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# THIRTY-SIXTH AND THIRTY-SEVENTH ANNUAL REPORTS

OF THE

# NORTH CAROLINA
# Agricultural Experiment Station

FOR THE

## YEARS ENDED JUNE 30, 1913 AND 1914

Bulls. 224-227

Tech. Bulls. Nos. 10 not included.

# BIENNIAL REPORT

OF THE

# NORTH CAROLINA

# Agricultural Experiment Station

FOR THE

## YEARS ENDED JUNE 30, 1913 AND 1914

BEING THE

## THIRTY-SIXTH ANNUAL REPORT

FOR THE

YEAR ENDED JUNE 30, 1913

AND THE

## THIRTY-SEVENTH ANNUAL REPORT

FOR THE

YEAR ENDED JUNE 30, 1914

INCLUDING

**Scientific and Other Papers and Bulletins**

RALEIGH
EDWARDS & BROUGHTON PRINTING CO.
1915

# THE NORTH CAROLINA
# AGRICULTURAL EXPERIMENT STATION

CONDUCTED JOINTLY BY THE

## STATE DEPARTMENT OF AGRICULTURE

AND THE

## N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS

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O. E. CLARK.....Assistant Director Edgecombe Branch Station, Rocky Mount
1E. G. MOSS.....Assistant Director Granville Branch Station, Oxford
S. O. PERKINS.....Assistant Director Buncombe and Transylvania Stations, Swannanoa

The members marked with * are members of the Joint Committee for Agricultural Work, and the Station is under their direction.

1In cooperation with the U. S. Department of Agriculture, Bureau of Plant Industry.
2In cooperation with the U. S. Department of Agriculture, Bureau of Soils.
3In cooperation with the U. S. Department of Agriculture, Bureau of Animal Industry.
4In cooperation with the U. S. Department of Agriculture, Office of Experiment Stations.

†Deceased

North Carolina Agricultural Experiment Station,
Office of the Director.

Raleigh, N. C., June 30, 1914.

*To His Excellency,* Locke Craig,
*Governor of North Carolina.*

Sir:—I have the honor to submit herewith the biennial report of the North Carolina Agricultural Experiment Station for the years 1913-1914. This includes the thirty-sixth and thirty-seventh annual reports of the Station for the years 1913 and 1914.

Very truly yours,

B. W. Kilgore,
*Director.*

# BIENNIAL REPORT

OF THE

# North Carolina Agricultural Experiment Station

**For the Years 1913 and 1914**

BEING THE

## THIRTY-SIXTH ANNUAL REPORT

**For the Year Ended June 30, 1913**

AND THE

## THIRTY-SEVENTH ANNUAL REPORT

**For the Year Ended June 30, 1914**

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BY THE DIRECTOR.

This report covers the work of the Station from July 1, 1912, through June 30, 1913, and from July 1, 1913, through June 30, 1914.

The most important step in the history of agricultural work in the State was taken during this period by the bringing together in one organization of all the agricultural workers connected with institutions having to do with agricultural work in the State. Under this arrangement the State Department of Agriculture and the College of Agriculture and Mechanic Arts joined together in the conduct of the Agricultural Experiment Station and the Extension Service, the former embracing all experimental or investigational work in agriculture, and the latter including demonstration, all club work and other services of an extension nature, by which the results of the investigations obtained in the Experiment Station are carried to the farmers by workers out in the State. The National Department of Agriculture cooperates with the two State institutions in the above undertakings and exercises its functions in connection with the joint work through its officials, by conferences and written agreements, while the two State institutions deal with the work through the "Joint Committee for Agricultural Work," made up of four members of each of the two Boards and the Commissioner of Agriculture and the President of the College.

This arrangement is legalized in Chapter 68 of the Public Laws of 1913, as follows:

*The General Assembly of North Carolina do enact:*

SECTION 1. That there is hereby authorized and legalized a joint committee to be known as the "Joint Committee for Agricultural Work"; that this committee shall be composed of four members of each of the boards of agriculture and the trustees of the North Carolina College of Agriculture and Mechanic Arts; and in addition thereto the Commissioner of Agriculture and the President of the North Carolina College of Agriculture and Mechanic Arts be *ex officio* members of said committee.

SEC. 2. That the four members of the joint committee from each of the two boards shall be designated by the board of which they are members respectively, and shall serve on the committee during their terms as members of the board, unless excused from such service by their respective

boards. The members already designated by the two boards for service on this committee shall continue to serve during their terms as board members.

SEC. 3. That for the purpose of preventing duplication and friction and for increasing efficiency in agricultural work in the State the joint committee for agricultural work heretofore provided for shall have supervision and control of such agricultural work of the same kind or kinds as both the Department of Agriculture of the State and the North Carolina College of Agriculture and Mechanic Arts are conducting or may conduct under authority of law, together with any work which either of these institutions may agree to place under the joint committee, and especially shall this joint committee have supervision and control of all experimental and investigational work in agriculture in the State.

SEC. 4. The joint committee shall use funds as may be designated by law or which may be placed at its disposal by each of the two boards or by any benefactions in the conduct of the work outlined in section 3 of this report. It shall determine and employ such workers as may be necessary for the conduct of the work and regulate their salaries and duties. All actions of the joint committee shall be subject to the approval of the Board of Agriculture and the Board of Trustees of the North Carolina College of Agriculture and Mechanic Arts.

SEC. 5. This act shall be in force from and after its ratification.

This act was ratified March 7, 1913.

The agreements for the joint conduct of all the agricultural work in the State of the same or similar kinds have been worked out voluntarily by the institutions having to do with them at a number of conferences of the boards, committees and officers, beginning on May 23, 1911, and extending to June 5, 1912, at which time a definite plan for the organization of the work was finally adopted and put into operation, the agreement to do this having been reached on January 24, 1912.

The joint work is supported from funds of the State Department of Agriculture, made available by appropriations of the Board, the special appropriations of Congress through the College of Agriculture and Mechanics Arts for the Experiment Station (Hatch and Adams funds), and the Extension Service (Smith-Lever fund), appropriations or donations from counties and allotment from the funds of the National Department of Agriculture for work in this State under a number of specific agreements.

Much time and careful thought have been given to working out well considered plans for the various undertakings. These plans have been presented from time to time to the Joint Committee and to the two Boards and are being carried out by the workers in an agreeable and thorough way.

The joint work is stronger than cooperation. It is in reality a union of the efforts of the State and National Departments of Agriculture and the College of Agriculture and Mechanic Arts, each having its share in the planning and control of the work and having, consequently, a corresponding interest and responsibility for the results. This union of forces has not only added strength to the efforts for the betterment of farming in the State, but is pleasing to the workers, because of the desirable relations in which they are placed toward each other and the

agricultural work in the State as a whole, and to the institutions having to do with it.

Under this joint arrangement the staff of the Station and Extension Service numbers 77 Technical Workers and 70 County Agents. The experimental workers are conducting a large amount of work to find new facts which will be helpful to the farming industry and the Extension workers are carrying the results direct to the farmer on the farm. This is a strong and effective arrangement.

The undertakings in which the various Divisions and workers are engaged are given in the reports of Divisions to be found in another part of this report.

PUBLICATIONS.

Bulletins have been issued as follows:

No. 224—Top-Working Seedling Pecan Trees, by W. N. Hutt.
No. 225—How Shall Farmers Organize, by W. R. Camp.
No. 226—Report of Variety Tests of Cotton for 1913, and Summary of Results for the Past Eleven Years, by R. Y. Winters.
No. 227—Fertilizer Experiments with Cotton on Piedmont Cecil Sandy Loam Soil and Varieties, Culture and Fertilization of Cotton on Piedmont Cecil Sandy Loam and Red Clay Soils, by C. B. Williams, B. W. Kilgore, and A. R. Russell.
No. 9 (Technical)—Relation of the Mineralogical and Chemical Composition to the Fertilizer Requirements of North Carolina Soils, by J. K. Plummer, Jr.
No. 10 (Technical)—Breeding Rotundifolia Grapes, by F. C. Reimer and L. R. Detjen.
No. 1 (Circular)—Silo Facts, by Alvin J. Reed.
No. 2 (Circular)—Beef Cattle and Sheep Barns, by R. S. Curtis.
No. 3 (Circular)—Improving Cotton by Seed Selection on the Farm, by R. Y. Winters.
No. 4 (Circular)—Curing Meat on the Farm, by Dan T. Gray.
No. 5. (Circular)—A Remedy for Cotton-seed Meal Poisoning, by W. A. Withers.
No. 6 (Circular)—Composition and Fertilizing Value of Farm Crops, by C. B. Williams.
No. 7 (Circular)—The Premier Clover for North Carolina Farmers, by C. B. Williams.
No. 8 (Circular)—Effects of Applying Commercial Fertilizers to Corn and Cotton by Different Methods, by C. B. Williams.
No. 9 (Circular)—Grass Mixtures for North Carolina Pastures, by C. B. Williams.
No. 10 (Circular)—Hairy Vetch, by C. B. Williams.
No. 11 (Circular)—Source, Availability and Suitability of Different Forms of Plant Food Constituents to Different Crops, by C. B. Williams.
No. 12 (Circular)—Effects of Different Fertilizing Materials upon the Maturity of Cotton, by C. B. Williams.
No. 13 (Circular)—Long Staple Cotton in North Carolina, by C. B. Williams.
No. 14 (Circular)—Buying Cotton Seed for Planting, by R. Y. Winters.
No. 15 (Circular)—Farmers' Clubs, their Organization and Work, by
No. 16. (Circular)—Results of Variety Tests of Cotton in Mecklenburg County, by C. B. Williams.
No. 17 (Circular)—Handbook for Boys' Corn Clubs, by T. E. Browne.
No. 18 (Circular)—Fertilization and Cultivation of Corn, Cotton and Tobacco, by C. B. Williams.
No. 19 (Circular)—Some Important Diseases of Tomato in North Carolina, by H. R. Fulton.

The reports of the heads of the several Divisions and financial statement follow:

# REPORT OF THE DIVISION OF AGRONOMY.

MR. B. W. KILGORE, *Director.*

DEAR SIR: I transmit herewith the report of the Agronomy Division of the Station for the fiscal years ended June 30, 1913, and June 30, 1914:

All the agronomic work that has thus far come under the charge of the Division has been so organized that each worker has a specific field of endeavor. The agronomic work is organized into the following sections:

(1) Soil Chemistry; (2) Soil Fertility; (3) Plant Breeding; (4) Soil Survey; and (5) Miscellaneous.

## SOIL CHEMISTRY.

During the years a goodly number of chemical and mineralogical analyses of different soils have been completed and tabulated for the Piedmont and Coastal Plain sections of the State. All the samples of soil were carefully taken with reference to soil type in the areas surveyed and mapped by soil survey parties. A bulletin giving the results of some of the mineralogical examinations of soils from various soil type areas of the different sections of North Carolina has been prepared and published. It is believed that the matter presented in this bulletin will not only be of considerable scientific value, but will be of immediate practical value in the interpretation of our soil fertility results with different crops grown experimentally on different types of soil in various sections of the State.

## SOIL FERTILITY INVESTIGATIONS.

The soil fertility investigations are well organized and progress in them is quite satisfactory. These experiments are being conducted on most of the leading soil types of the State to determine, among other things, the chief plant-food deficiencies of the different types of soil for the chief crops of the various sections. At present, in these investigations, there are 147 plats at the Iredell farm; 96 at the Buncombe farm; 155 at the Edgecombe farm; 167 at the Central farm, and 36 plats each at the Oxford and Reidsville farms, these latter being chiefly with tobacco. In addition to these, we have thirteen experiments of ten to fifteen plats each on twelve different soil type fields in various parts of the State. These plats are located with farmers. We look closely after applying the fertilizers to plats of these different fields; give directions for cultivating them, and send a man in every case to look after harvesting and weighing the crop produced by the plats of the various fields. So far as possible, a visit or two is made to the different fields during the growing season to see how the experiments are progressing and to take such notes and make such photographs as seem desirable. Two bulletins have been prepared and published during the year giving seven

years' results at the Edgecombe test farm and eight years' results at the Central farm in fertilizer tests with cotton.

PLANT BREEDING.

The efforts of workers in this sub-division are confined chiefly to breeding experiments with field crops with the primary object in view of securing varieties and types of crops suited to the different soils in the various localities of the State. Much time at present is being devoted to a careful comparative field study of the various varieties of the different crops already known when grown under different soils and climatic conditions. It is considered that this field study of varieties will not only supply farmers with a great deal of valuable information they are seeking each year, but the data secured from such tests, carefully conducted under varying soils and conditions will form the basis in many cases for starting breeding experiments designed to improve some type or variety of crop to fit it the better for the purposes and for the conditions under which it is to be grown.

At present Dr. Winters is devoting his attention chiefly to breeding and to a study of varieties and types of cotton, cowpeas, soy beans, vetch, and velvet beans best adapted to our conditions; while Mr. Burgess, assisted by Mr. Garren, is working chiefly along the same lines with corn, wheat, oats and rye. Some work is also being conducted with wheat in the way of determining the best date of seeding in the fall and the best method of preparing the land for fall seeding of this crop. The investigations designed to determine the place effect upon the character of cotton and the effect of the growth of suckers upon the yield and growth of the corn plant have been continued. It is contemplated that as the work of organization progresses within the division other field crops will be taken up and studied in a detailed scientific way. Some breeding work is already in progress with tobacco at Oxford and at Reidsville.

SOIL SURVEY.

The soil survey has been conducted along the same general lines as in previous years. Two parties have been in the field most of the time and three part of the time. At the present time we have good maps of Ashe, Bladen, Buncombe, Cabarrus, Caswell, Chowan, Craven, Duplin, Edgecombe, Forsyth, Gaston, Granville, Henderson, Johnston, Mecklenburg, Mitchell, New Hanover, Pasquotank, Pender, Perquimans, Pitt, Randolph, Richmond, Robeson, Scotland and Transylvania. A plan has been agreed upon by which the work will be continued in a systematic way.

This basic work with our soils is being pushed as aggressively as funds will permit.

MISCELLANEOUS EXPERIMENTS.

During the falls of 1912 and 1913 a large number of individual grasses and grass mixtures were seeded at the Central, Iredell, Bun-

combe, Edgecombe and Granville farms to study their value for pasture and for hay when grown under the various soil and climatic conditions represented by these different farms. In all there were put out more than 250 different plats to the different grasses and mixtures. On most of the various farms under the control of the Station there are in operation many rotation, culture and tillage experiments with the leading crops of the various sections.

In addition to the publications mentioned above, this Division has prepared a bulletin which gives the results of variety tests of corn in 1913 and twelve circulars on different crops; on types and varieties of cotton; on proper methods to use in selecting cotton seed for planting; on the composition and fertilizing value of farm crops and other farm materials; on grass mixtures for pasturage, and on hairy vetch and crimson clover. It has also aided in the preparation of a circular on Farmers' Clubs, their Organization and Work.

Respectfully submitted,

C. B. WILLIAMS,
*Chief, Division of Agronomy.*

## REPORT OF THE DIVISION OF CHEMISTRY.

I have the honor to submit the following report of the Chemistry Division for the two years ended June 30, 1914:

During this period the Division was engaged principally with two projects, viz.: Cotton-Seed Meal Poisoning and Soil Bacteriology as it relates to nitrogen transformations. Some attention was given also to other lines of work, viz.: to some analyses for the Agronomy Division, to the analysis of some fats for the Animal Husbandry Division and to the study of the areas in western North Carolina suitable to sugar beet culture.

The sugar beet work was in collaboration with the Bureau of Plant Industry of the U. S. Department of Agriculture. The seeds were distributed from the Bureau in Washington for two years to the parties upon recommendation of this Division. The samples were analyzed by the Bureau of Chemistry of the Department.

### SOIL BACTERIOLOGY.

The work in Soil Bacteriology has been in collaboration with the Division of Botany and Soil Bacteriology. The experiments have been with plats, with pots, and with solutions. The samples in which soil was used were taken from time to time during the year. The analyses showed variations in the amount of nitrates from time to time and indicated in consequence that the nitrifying power of the soil sampled at a certain time and under certain conditions, would not be a reliable index as to the nitrifying power of the same soil sampled at a different time.

We have found also that the same soil will show a difference in nitrifying power depending upon the fertilizer application during previous seasons, also that there is a variation depending upon the water content of the soil. We have also confirmed previous conclusions that there is great variation in nitrification depending upon the form of the nitrogen supplied.

These conclusions indicate to us the desirability of studies in nitrification which shall be more fundamental in character. We are now endeavoring to study the nitrifying power of various cultures, as nearly pure as we can get them and are using in this study various media. We are also attempting to study the gaseous substances produced, particularly those containing nitrogen and we are endeavoring to utilize electrical methods to study the changes which take place from day to day.

Connected with this work we have made a conductivity study of the reactions between calcium nitrate and dipotassium phosphate in dilute solution.

### COTTON-SEED MEAL POISONING.

We have fed Cotton-seed Meal to guinea pigs, rabbits, swine, and a calf and have found it poisonous to each of these classes of animals, although during some of the experiments some of the animals did not die.

We used a great many solvents in our efforts to isolate the toxic substance, and since the termination of the period embraced by this report, have isolated a substance which seems to us to be the main toxic principle. As a result of our studies we have found two methods by which the toxic properties of the meal have been overcome partially if not entirely. These methods are treatment of the meal with an alcoholic solution of an alkali and secondly the treatment of the meal with the solution of an iron salt. The first method appears to oxidize the toxic principle and the second method appears either to render it more difficult of solution or to serve as a tonic to the animal. The first method has proven effective with rabbits and the second method has proven effective with both rabbits and swine.

PAPERS READ AND PUBLISHED.

During the period covered by the report the following papers have been read or published as stated:

"A Method for the Removal of the Toxic Properties of Cotton-seed Meal." Published in *Science*, Vol. 36, pp. 31-32 (July 5, 1912).

"Studies in Cotton-seed Meal Intoxication. As to Pyrophosphoric Acid." Published in the *Journal of Biological Chemistry*, Vol. 14, pp. 53-58 (March, 1913).

"Studies in the Toxicity of Cotton-seed Meal." Read before the Society for the Promotion of Agricultural Science, Atlanta, Ga., October, 1912, and published in the proceedings of the Society for 1912.

"Study of the Renal Output of Rabbits Poisoned by Cotton-seed Meal." Read before the North Carolina Section of the American Chemical Society, June 18, 1913.

"Studies on Cotton-seed Meal Toxicity. Iron as an Antidote." Read before the North Carolina Academy of Science at Greensboro, April 26, 1913, and published in the *Journal of Biological Chemistry*, Vol. 15, pp. 161-166 (July, 1913).

"A Remedy for Cotton-seed Meal Poisoning." Read before the Farmers' State Convention at Raleigh, August 27, 1913, and published as Circular 5 of this Station, October 29, 1913. This article was republished in the *National Provisioner* of New York, November 15, 1913, the *Progressive Farmer* of Raleigh, and in various other agricultural papers and journals. A review of the article by President A. M. Soule, of the Georgia A. & M. College appeared in the *Cotton and Cotton Oil News* of Dallas, Texas, and Memphis, Tenn., January 5, 1914, and in the *Oil Miller* of Atlanta, Ga., March, 1914. The latter journal reprinted the article November, 1914, stating that over two hundred requests for the issue containing it had been received from all classes and from all sections of the United States.

"An Electrical Contact Vapor Pressure Thermoregulator." Read before the North Carolina Section of the American Chemical Society, June 24, 1914, and published in the *Journal of the American Chemical Society*, Vol. 36, pp. 72-76 (January, 1914).

"Studies in the Toxicity of Cotton-seed Meal." Read before the Convention of Southern Agricultural Workers, Montgomery, Ala., February 24-26, 1914.

"Sulphur Linkage in the Proteins." Read before the North Carolina Section of the American Chemical Society, May, 1914.

"Some reactions which occur in Nutrient Nitrifying Solutions." Read at the same time.

"Some Properties of Congo Red." Read at the same time.

"A Conductivity Study of the Reactions between Calcium Nitrate and Dipotassium Phosphate in Dilute Solution." Read at the same time and

now in the hands of the editor of the *Journal of the American Chemical Society* for publication.

"Cotton-seed Meal as a Hog Feed." Read before the South Carolina Cotton-seed Crushers Association, June 17, 1914, and published in the *Oil Miller*, Atlanta, Ga., August, 1914.

I take pleasure in submitting herewith for publication some articles alluded to above, but not yet published.

Very respectfully,

W. A. Withers,

*Chemist.*

## REPORT OF DIVISION OF ENTOMOLOGY.

MR. B. W. KILGORE, *Director.*

SIR: I present herewith a brief review of the work in experimental and investigational lines, in Entomology, which has been done during the past two years.

### POTATO SPRAYING FOR FLEA-BEETLE CONTROL.

Tests were made on the Buncombe Test Farm in 1913 to determine the best ways and means to protect late Irish potatoes from attacks of Flea-beetle, taking into consideration not only the effect on Flea-beetles themselves, but also noting the yields of all plats under treatment. Similar tests are under way with the crop of 1914, final results from which have not yet been secured. We hope to determine the spray material and the schedule of applications, for the best control of Flea-beetle, and at the same time to control other pests which affect this crop. This line of work is being carried on by Assistant Entomologist, Mr. C. L. Metcalf.

### WOOLLY APHIS OF APPLE.

During 1913 tests were made of different strengths of oil emulsion and of tobacco extract (Black Leaf 40), to control the root form of Woolly Aphis on apple trees. The results thus far are in favor of the tobacco extract. Some additional tests are yet to be made. This work is being done by Mr. C. L. Metcalf, chiefly on the Buncombe Test Farm.

### PECAN INSECTS.

About a year ago we started a study of the insects affecting the pecan. Although at the present time the serious insect pests of this tree are few in number, yet there are many pecan enemies which may become more serious with the increase of pecan planting now in evidence. Even with the more important pests, much information is yet needed in regard to exact habits and life histories. Mr. Metcalf is carrying out this project and is securing much valuable data, some of which may require considerable time for full completion and ample corroboration. Thus far he has followed some of the insects throughout one whole year of their activities, and has several times reared mature insects from larvae which were unknown at the time they were first found. Thus he is learning both the identity and the life histories of some of these insects concerning which we had no data before. It is planned to test methods for control as fast as conditions will permit when the necessary biological facts are at hand to indicate the most promising remedies.

### REMEDIES FOR APHIDS.

For several years I have been interested in seeking a more simple and more available remedy for the common aphids, than the oil emulsion

and tobacco extracts which are commonly recommended. While recognizing that the oil and tobacco preparations have greater penetrative qualities which may make them more desirable for controlling the root-inhabiting or especially resistant forms of plant-lice, I have been able to prove to my own satisfaction that simple solutions of ordinary brands of laundry soap in water, will give good results against many of our most common aphid pests. While the efficiency of soap solutions is generally suggested in bulletins and text books, yet very seldom are there specific statements as to the exact quantity of the materials to use. We hope to reduce this matter to a more definite basis.

### PEACH SPRAYING EXPERIMENTS.

This year (1914) the spraying of the orchards on the Test Farms was assigned to this Division, and we at once made plans for some tests in the spraying of peach trees. These tests were carried out by myself with help of my Assistant, Mr. S. C. Clapp. We used different strengths of commercial lime-sulphur solution with arsenate of lead, with and without the addition of different quantities of blue-stone (copper sulphate), and in some tests used arsenate of lead (without lime-sulphur), both with and without the addition of lime. For comparison, we also had trees which were sprayed with the standard self-boiled lime-sulphur with arsenate of lead, and trees which were not sprayed at all. The observations and data from these tests have all been recorded.

### ARMY WORM OUTBREAK OF 1914.

As this report is written we have lately had an important outbreak of the army worm (*H. unipuncta*), and there is a chance that another destructive generation of it may appear before the winter season. The outbreak of this year was unique in many of its aspects, not merely in this State, but in the country at large. Mr. Metcalf and myself at once began a series of observations on the activity of the natural enemies of the army worm, particularly of a certain parasitic fly, and by confining many worms in cages we have secured considerable accurate data which throws light upon the normal control of this pest by its parasites. While we found no opportunity for accurate tests of remedies, yet all inquirers were sent a statement of the recognized methods of control which might be used, and by circular letter we have since gathered the opinions and experience of a considerable number of farmers. Altogether the outbreak of this year has given us more first-hand data than all the years since 1900 had given us before.

### RED SPIDER OF COTTON.

Mr. Metcalf has also made a considerable number of observations and tests relative to the "red spider" (a mite) of cotton, and its control. Work by agents of the U. S. Bureau of Entomology, located in South

Carolina, has been along much the same lines, and Mr. Metcalf's observations have indicated that the results secured in South Carolina are in the main applicable in this State.

Very respectfully submitted,

FRANKLIN SHERMAN, JR.,
*Chief, Division of Entomology.*

## REPORT OF ENTOMOLOGIST.

I am submitting, herewith, report for the years 1913-1914.

Most of the time of the Entomologist has been devoted to the three projects now under consideration; the Corn-bill Bug, the Gloomy Scale and the Cow-pea Weevils.

*Corn-bill Bug.*—Most of the work done on this project has been done at the Pender Test Farm where we have had a plot of ground for this purpose. Many detailed observations on the life history of this insect, which need not be repeated here, have been made in the field, and these have been checked up with extensive observations in the insectary and laboratory.

A series of experiments for the control of this pest has been tried in the field. A number of repellants, such as rock phosphate, complete fertilizer, lime and tobacco dust have been tried but none of them have proven successful.

Early planted corn seems to be more resistant to the attacks of the Corn-bill Bug than late planted corn. Corn planted on ridges is somewhat more resistant than corn planted on the flat. This latter remedy would be applicable only to early corn grown for roasting ears for shipment to the northern markets.

Our work in the field on the Corn-bill Bug has been somewhat handicapped during the past year owing to the long continued and extreme drought during the early part of the year. In addition the Southern Corn Root Worm has complicated results by doing more damage than usual. Yet in spite of these very abnormal conditions the Corn-bill Bug has done a large amount of damage this past year.

*Gloomy Scale.*—The greater amount of time devoted to the Gloomy Scale has been devoted to a study of its life history, especially from the standpoint of the normal increase of this insect, the number of young born by each female and the percentage of the young that are able to attach themselves.

The past year has been a very favorable one for the parasites of the Gloomy Scale, and considerable study has been placed on this phase of the question. So far all the parasites found belong to one species, and the life history of this parasite has been studied in detail.

A number of technical experiments have been performed in the hope that we could discover some reason why certain classes of insecticides are more effective against the Gloomy Scale than others, but up to the present time we have not been able to settle this point satisfactorily.

*Cow-pea Weevil.*—Large numbers of experiments have been carried on with this species in order to determine the number of eggs laid by each female, the proportion of fertile eggs and other points of interest about the life history. In addition a series of experiments was run

with six varieties of cow-peas and one variety of soy bean to determine the relative infestation of the various varieties, but eggs were laid on all varieties in approximately the same numbers. The soy beans consistently show a much lower rate of infestation than the cow-peas.

Peas mixed with lime passed through storage better than peas fumigated with carbon bisulphide in a very tight bin. Kerosene and crude carbolic acid gave satisfactory results. These points need to be verified and further elaborated. If it can be demonstrated that peas stored in lime are weevil free, it will mean a great saving to the farmer and seedsmen who handle cow-peas.

### MINOR OBSERVATIONS AND EXPERIMENTS.

At the request of the authorities at the State Hospital we have outlined a plan for reducing the numbers of house flies about the buildings of that institution. Our preliminary survey has shown that the sanitary measures in force about the buildings and grounds are of a very high order, but in spite of these facts there are a large number of house flies present. It is hoped that by means of the simple plan outlined that in another year the flies may be materially reduced. The situation at the State Hospital offers an excellent opportunity to try out on a small scale our best remedies against house flies, but at the same time it will also afford us an opportunity to try out methods on a sufficiently large scale to determine their applicability to small cities and towns.

The past year has afforded the usual number of pests of the crops grown on the farms of the State, and several insects of local importance have demanded the attention of the Entomologist from time to time. This has been especially true of insect pests of shade trees in cities and towns. Of the other insects observed during the past two years the more important have been the Corn Stalk Borer, the Army Worm, the Bean Leaf Beetle and the Catalpa Worms.

Respectfully submitted,

Z. P. METCALF,

*Entomologist.*

## REPORT OF THE DIVISION OF HORTICULTURE.

The experimental work in Horticulture has been very largely confined to the Test Farms. Having trained superintendents and being situated with especial reference to soil types suitable for various horticultural crops these farms afford excellent facilities for horticultural experimental work. As these farms are the property of the State, and have been definitely set apart for crop testing work, it was thought wise to make rather extensive plantings of the horticultural crops suited to the particular soil type on which each farm is located. In accordance with this plan, orchards of apple and peach have been planted on the mountain farms to determine the varieties and cultural methods best suited to these sections. As the trees are not yet in full bearing the work has up to this time been very largely confined to the study of cultural methods.

Experiments have been begun on the mountain farm to study the culture of the heavy truck crops (potato and cabbage), so largely grown in the mountain sections. In the eastern and southern parts of the State comprehensive experiments are under way to test the suitability of those sections for the commercial culture of the pecan. A large collection of varieties has been planted and valuable data have been secured. Two bulletins on this subject have already been published by the State Department of Agriculture and data is being secured for future publications. Four years ago preliminary work was begun to ascertain the best methods of "working over" seedling pecan trees with scions of standard varieties. Various methods have been tried during each succeeding season. The "patch-budding" method was found to be most satisfactory and a bulletin was published last winter (No. 224 North Carolina Experiment Station), describing this method in detail.

Two years ago work was begun on the testing of air-cooled apple storage houses as to their value in the storage of winter apples. Two houses were equipped with self-recording hygro-thermographs and a continuous record of the variations of temperature and humidity kept during the entire storage periods. These instruments were checked daily from standard Weather Bureau maximum and minimum thermometers in the storage chamber and also outside. It was found that when temperatures outside would vary as much as 50 degrees that the temperature inside the storage chamber did not fluctuate over 8 degrees. Winter apples were kept in these storage houses in good condition as late as May. On account of the delicate and very expensive instruments required it was not possible to keep thermograph records in all the houses under observation, but notes were kept as to the results obtained in the general storing of the fruit. A bulletin has been prepared giving the results of these experiments and has been sent to the printers as bulletin No. 228 of the North Carolina Experiment Station series.

On the Southeastern Test Farm at Willard, an extensive planting of Rotundifolia grapes has been made in cooperation with the Division of Pomology of the National Department of Agriculture. Tests are being made of the best varieties and types of this species of grapes gathered from the entire native range of the species.

Experiments are also in progress to test the cultural methods best suited in handling this native wild species. A great many crosses have been made between varieties and hybrids between the muscadine and related species of grapes, in order to improve the type and if possible increase the bunching habit and produce varieties more suitable for dessert purposes.

On the Test Farms work is in progress in testing the best cultural methods and fertilizers required to produce strawberries and cantaloupes.

For two seasons records have been kept on the storage of sweet potatoes in a house, especially constructed for the purpose. Careful thermograph records have been kept during the entire storage period.

This last season an experimental planting of summer apples was made on the Test Farm at Willard. These trees will be given every attention to get the orchard into early bearing in order to test the practicability of the commercial culture of early apples in Eastern Carolina.

For the last three years an extensive series of observations have been in progress in co-operation with the Weather Bureau of the National Department of Agriculture to study the phenomena known as "thermal zones." Sixteen observing stations have been located on mountain slopes in Western Carolina and data is being recorded by self-registering instruments. Very remarkable differences in temperature have been recorded on long slopes which give promise of valuable experimental and also practical results. It has been decided to continue the recording of data for two years more before any definite conclusions are drawn.

W. N. HUTT,
*Chief, Division of Horticulture.*

## REPORT OF HORTICULTURIST.

Mr. B. W. Kilgore, *Director.*

Dear Sir: I am submitting the following report of the work in Horticulture on the College grounds, West Raleigh, covering the two years ending July 1, 1914.

The principal lines of work have been those carried on under the provisions of the Adams Act, and are as follows:

1. *A Study of Self-sterility in Blackberries, Dewberries and Muscadine Grapes.*—This experiment resolves itself naturally into two parts; viz., (a) Muscadine Grapes, and (b) Blackberries and Dewberries. The work with Muscadine Grapes has been completed, and the results published. That with Blackberries and Dewberries has been completed, but the data has not yet been prepared for publication.

2. *A Study of Transmission of Characters of Hybrids of Muscadine Grapes.*—This experiment has been the chief subject of interest. It was started by Professor Reimer, now of Medford, Oregon, in 1909, and was conducted by him until his resignation in the summer of 1911. Since that time his work has been continued along the lines originally determined upon in order to complete the observations already partially made. During the past year, Professor Reimer, who was in charge in 1911, has, by previous agreement, and in conjunction with Mr. Detjen, written the first report of the results of this work. This is now in the hands of the printer, and will be issued shortly.

This experiment is of such a nature that it will be likely to extend over a period of several years more. There are other very important characters that have not as yet been studied sufficiently and observations as to the trend of results toward the origination of new varieties should be valuable derivatives of the work.

In the last report it seemed necessary to recommend that an additional plot of land be set aside for the continuation of this experiment, but subsequent experience indicates that this will not be needed.

The secondary experiments have been supported by the proceeds of the Hatch fund, and are as follows:

1. *A Study of the Influence of Plant Food on Pollen.*—This experiment was brought to a temporary stop because there was no greenhouse space in which to carry it on. Until such space is provided work along this line will have to be abandoned.

2. *The Self-sterility of Persimmons* is a project which has recently been taken up. Temporary space has been assigned for this work by the College Horticultural Department, but as this is so dangerously near the railroads and liable to injury or destruction by burning, some other location will be necessary.

3. *A Study of the Effect of Different Methods of Pruning Apple Trees* is the title of a project inaugurated in February, 1910. The trees under observation constitute a part of the College orchard, and

are, therefore, not in a position to be maintained inviolate for purposes of experimentation. Furthermore, an experiment along this line is worthy of extended and exhaustive observation, and it is hoped that proper facilities for such work be provided before any future effort to obtain information of this character. The present experiment is so narrow in its scope that the Horticulturist recommends that it be dropped.

Respectfully,

J. P. PILLSBURY,
*Horticulturist.*

# REPORT OF THE ANIMAL INDUSTRY DIVISION.

Mr. B. W. Kilgore, *Director.*

My dear Sir: The following statements give a brief summary of the work conducted by the Animal Industry Division for the two fiscal years ending June, 1914.

## SWINE.

1. To determine the toxic principle in cotton-seed meal.

This work is being done in coöperation with the Divisions of Chemistry and Veterinary Medicine. During the winter of 1912-13, 30 pigs were employed in the test. The same number was used in 1913-14.

2. To determine the value of temporary pasture crops for fattening hogs when these crops are used in conjunction with skim milk.

This work is being done upon the Pender and Edgecombe Test Farms. During the winter of 1913-14 an experiment was made to determine the value of rape and oat pastures as feeds for fattening pigs. During the fall of 1913 another test was made to determine the value of a mixture of cow-peas and soy beans when planted in a peach orchard.

3. To determine the value of waste peanuts as a feed for hogs.

This work was done in coöperation with Mr. George A. Holderness, of Tarboro, N. C. Two hundred and fifty hogs were fattened on the peanuts left in the ground after the usual amount was harvested.

4. To determine the effect of peanuts, soy beans, mast, and other softening feeds upon the bodies of hogs and their lards with a view to developing a plan of feeding to counteract these unfavorable results.

Samples of lard were taken from each of the above hogs but these samples have not, as yet, been studied.

5. To determine the expense of raising pigs to the weaning age in the Coastal and Piedmont sections of North Carolina.

This work is being done on the Pender and Iredell Test Farms. A small herd of hogs is being maintained on each farm and a special study is being made of the value of winter crops for breeding herds of hogs.

6. During the winter of 1913-14 a Home-Made Meat Club was organized for the benefit of the mature farmers of the State. No special effort was made to secure members yet 500 farmers joined the club and are growing grazing crops and feeding their hogs according to directions sent out by the Division.

## BEEF CATTLE.

1. To determine the relative value of various quantities of cotton-seed meal for fattening steers in connection with cotton-seed hulls and corn silage, and note the effect of these feeds upon the quality of the meat.

During the fiscal year of 1912-13, 48 steers were used in this ex-

periment. During the fiscal year of 1913-14, 76 steers were fed. This work was done on the Central Farm at Raleigh.

2. To make a direct comparison of the relative value of cotton-seed hulls and corn silage when fed in conjunction with cotton-seed meal, and determine the effect of each combination of feed upon the quality of the meat.

Fifty head of beef animals, divided into two lots, were used in this test. The steers were fed on the Iredell Test Farm.

3. To determine the value of shelter in feeding beef cattle on the sandy soils of North Carolina, and determine the value of manure when dropped directly upon these soils by the steers.

This work was done in coöperation with Mr. R. A. Derby, of Moore County, 30 head of steers being used.

4. Coöperative beef cattle work with the Bureau of Animal Industry, Washington, D. C., conducted on the farm of Mr. T. L. Gwyn, of Haywood County. These experiments were inaugurated November 1, 1913. Since that date the following work has been done:

(a) To determine the profit, if any, in introducing corn into a ration of cotton-seed meal. Twenty-four steers, divided into two lots, were employed in this test.

(b) To determine the best and most economical method of wintering stockers when they are to be finished the following summer on pasture. One hundred and two stockers, divided into four lots and fed upon different rations, were used in this winter work.

(c) To determine the feasibility and practicability of fattening cattle in the summer on pasture when the pasture is supplemented with cotton-seed cake. One hundred and two steers are being used in this test.

5. During the year wide interest has been awakened in helping the farmers and feeders in buying feeding cattle. Approximately 1,000 head of feeding cattle have been purchased for farmers located in various parts of the State. Representatives from this Division were stationed in the mountains and looked after the grading and shipping of the cattle. After the cattle reached their destinations regular trips were made by these same representatives to the farmers' homes and advice given concerning the handling, feeding and shipping. Many breeding animals have also been purchased for our farmers by these representatives.

### SHEEP.

At the present time the sheep work is being conducted at the Central Experiment Farm and at the Edgecombe Test Farm. Upon the Central Farm, at Raleigh, is a flock of approximately 100 sheep. They are divided into lots and the following questions are being studied:

1. To determine the cost of maintaining a flock of sheep.

2. To determine the cost and feasibility of producing early lambs for the April, May and June markets.

3. To determine the effect of cotton-seed meal rations, when fed in various quantities, upon the health, condition, and reproductive systems of the animals.

4. To determine the value of the use of Merino, Shropshire and Barbado rams in grading up native ewes, and in crossing upon each other.

5. To determine whether the Barbado sheep are in any degree resistant to the attacks of the stomach worms.

6. To determine the effect of a high ration of cotton-seed meal on the character of mutton and also the comparative susceptibility of beef cattle and sheep to the toxicity of cotton-seed meal.

7. To determine the profits, if any, in purchasing ewes and lambs and fattening them during the spring and summer months on burr clover and vetch. A flock of twenty ewes and their lambs was used in this test which was conducted at the Edgecombe Farm.

### DAIRY EXPERIMENTATION.

As arranged at the present time practically all of the dairy experimental work is being done on the Pender Test Farm. It is hoped that the manufacturing phases of the work may be moved to Raleigh sometime during the year. The herd at the Pender Test Farm is now in good working condition and the following experiments are being conducted:

1. To determine the cost of raising dairy calves in the South. A complete record is being kept of the expense of raising each calf.

2. To determine the exact value of silage when compared with southern dry feeds. During the winter of 1913-14 the herd of milking cows was divided into two lots and a direct comparison was made between silage and cotton seed hulls.

3. To determine the value of silage as compared with winter and spring pastures.

At the close of the winter feeding work the herd of dairy cows was again divided into two lots and a study made of the value of silage as compared with early spring pastures.

4. To determine the value of various winter feeds for wintering dairy calves, special emphasis being given to cotton seed meal.

The young herd of dairy calves was divided into two lots and a study made of the value of introducing wheat bran into a cotton seed meal ration.

5. To determine the best and most satisfactory method of making skim milk buttermilk and cottage cheese.

6. To determine, if possible, a practical method of eliminating onion flavors from milk and butter.

Preliminary studies have been made to determine the length of time intervening between the time of eating onions and the appearance of the flavor in the milk and also its complete disappearance. Numerous

tests have been made to determine the virtue, if any, of molasses feeds for eliminating the onion flavors.

### HORSES AND MULES.

Work is being done in feeding horses and mules at the Pender and Iredell Test Farms. The work animals on these farms are divided into two lots and a study is being made to determine the place of cotton seed meal as a feed for work animals. Fourteen horses and mules are employed in this test.

A complete record is also being kept of the kind and amount of feeds eaten by each individual in the Percheron herd, amount of work done by each animal, and the amount of labor required to look after and care for them. In time we will have complete information as to the cost of raising Percheron colts on this test farm.

### POULTRY.

The following poultry work is being done:

1. On the Iredell Test Farm is kept a flock of hens for experimental purposes. Two principal objects are in view in doing this work:

(a) To determine the profits, if any, in keeping a farm flock of hens under ordinary farm conditions.

(b) To determine the value of the various winter crops for feeding laying hens.

Complete records, of course, are being kept of the amount of feed eaten, number of eggs laid, deaths, etc.

2. The authorities of the Bureau of Animal Industry, at Washington, D. C., are coöperating with us in the poultry club work. This work was inaugurated January 20, 1914, in Catawba, Iredell, Mecklenburg, Anson and Wake counties. Although the work was started late the total membership is now 324 children.

### DAIRY FARMING.

The Bureau of Animal Industry, at Washington, D. C., is also cooperating with us in the dairy farming work. During the last fiscal year the following results have been accomplished:

1. *Cow Testing Associations.*—Two cow testing associations have been organized. About 700 cows are being tested regularly in these two associations.

2. *Buildings.*—67 silos, 29 barns, 7 milk houses, 3 manure pits and 1 creamery have been built under the direction of the workers of this division.

3. *Dairy Schools.*—A number of dairy schools have been conducted throughout the State during the fall and winter. These schools are of three classes:

(a) One-Day Meetings in which communities ask for meetings.

(b) Three-Day-Short-Courses which are given in the vicinity of creameries.

(c) Coöperative Schools with country schools where a course of five or six sessions is given one day in each month during the school year.

4. *Cheese Work.*—In May, 1913, a trip was made in the northwestern part of the State for the purpose of investigating the possibilities of that section for cheese making. In May, 1914, another personal investigation was made by a cheese expert from Washington and recommendations were made that an effort be made to develop the cheese industry in the mountain section. A cheese expert will be put in charge of this work just as soon as a competent man can be found.

ORGANIZATION.

January 1, 1913, I became associated with this institution and the work in animal industry was reörganized. Mr. R. S. Curtis was made Associate Chief in Animal Industry and placed in charge of the investigation work with beef cattle and sheep; Mr. W. H. Eaton was placed in charge of the dairy experimental work; Mr. Alvin J. Reed, working in coöperation with the Bureau of Animal Industry, Washington, D. C., was placed in charge of the dairy farming investigations; Mr. C. B. Ross, also working in coöperation with the Bureau of Animal Industry, has been placed in charge of the poultry club work; Mr. Shook and myself have planned to carry on the swine investigation work.

In closing I wish to commend all of the members of this Division for their loyalty, for their earnestness, and for their independent thinking.

Very respectfully submitted,

Dan T. Gray,
*Chief, Animal Industry Division.*

## REPORT OF THE DIVISION OF VETERINARY SCIENCE.

I have pleasure in submitting herewith the report of the Veterinary Division for the past two fiscal years ending June 30, 1914.

In correlating with the Animal Husbandry and Chemical Divisions we have continued our part in the investigation of the ill effects produced by feeding cotton-seed meal to swine and experimental animals.

A large part of the recent observations were made upon rabbits and swine that had been fed cotton-seed meal with an iron salt or with ashes as a corrective. Other rabbits and swine were fed cotton-seed meal without these correctives to serve as checks. Both of the above agents proved very efficient in overcoming the usual ill effects from feeding cotton-seed meal to rabbits and swine.

General observations were made for the study of clinical symptoms upon 212 rabbits and upon 46 swine.

One hundred and seventy-six rabbits had received cotton-seed meal without a corrective agent. Twelve rabbits received iron and ammonium citrate as a corrective with their cotton-seed meal. Twenty-four rabbits received some form of calcium as a corrective with their cotton-seed meal.

Ten swine had received cotton-seed meal without a corrective agent. Fifteen swine received sulphate of iron (copperas) as a corrective with their cotton-seed meal. Nine swine received chloride of iron as a corrective with their cotton-seed meal. Six swine received wood ashes as a corrective with their cotton-seed meal. Six swine received ashes and sulphate of iron as a corrective with their cotton-seed meal.

The most characteristic clinical symptoms in swine, as noted from the beginning of our experiments in feeding cotton-seed meal, have been: rather firm feces (though diarrhoea was present in a few cases); rough coarse hair, indicating unthrift; irregular or loss of appetite, especially for the cotton-seed meal; weakness; unsteady gait; more or less loss of sight and very difficult breathing. Animals would finally get down unable to rise and lie there either in a comatose condition or in a constant struggle to regain their feet,—often grunting as if in pain or distress. Death would follow in a few hours to several days. Many animals, however, that appeared hale and hearty at the evening meal were found dead the following morning.

The most conspicuous symptoms in rabbits and guinea pigs consisted of rapid breathing, lassitude, prostration and death in a few hours. Sometimes there were continuous movements of limbs after prostration as if to regain their feet, while in others there were no such movements.

A comparative study of some of the characteristics of blood from swine fed cotton-seed meal with and without correctives was made. This examination was suggested by the frequency in which dirt, sand and gravel were found in stomach and intestines at autopsy of swine

dead of cotton-seed meal feeding and in the light of the beneficial effects of iron and of wood ashes when fed with the cotton-seed meal.

The examination of all samples of blood consisted of noting the percentage of haemoglobin. In other samples the percentage of corpuscles by use of haematokrit and the numbers of red and of white corpuscles per cubic millimeter were determined. A differential leucocytic count was also made.

The haemoglobin content with different lots varied as follows:

Check pig without cotton-seed meal nor corrective, 85 per cent.
Lot receiving cotton-seed meal without corrective, 80-95 per cent.
Lot receiving cotton-seed meal and chloride of iron, 80-95 per cent.
Lot receiving cotton-seed meal and sulphate of iron, 85-100 per cent.
Lot receiving cotton-seed meal and wood ashes, 85-100 per cent.
Lot receiving cotton-seed meal, wood ashes and sulphate of iron, 90-95 per cent.

As regards the variations of haemoglobin, and also of the other characteristics of blood, they were as great among individuals of the same lot as between those of different lots. These results bear out former observations that cotton-seed meal has little apparent effect upon the above-mentioned features of the blood.

Autopsies were held upon 72 rabbits and 13 swine.

60 rabbits had received cotton-seed meal without corrective.
12 rabbits had received cotton-seed meal and calcium hydroxide.
7 swine had received cotton-seed meal without corrective.
4 swine had received cotton-seed meal and sulphate of iron.
2 swine had received cotton-seed meal and chloride of iron.

Little difference in any of the lesions found in the various lots was noted, except the absence of thrombi (ante mortem clots) in all of the six deaths on iron.

The most frequent lesions found upon autopsy of animals dead from cotton-seed meal feeding were as previously noted in a former annual report, namely: excess chest and abdominal fluids, congestion of various organs, more or less edema of lungs and frequent thrombi (ante mortem clots) in the heart.

The principal difference in the lesions of rabbits and guinea pigs, contrasted with those of swine, consisted in the greater excess of abdominal fluid over the chest fluid of the former while the reverse was true of the latter.

Slaughter observations were made upon the following swine:

4 swine receiving iron sulphate with cotton-seed meal.
1 swine receiving iron chloride with cotton-seed meal.
5 swine receiving wood ashes with cotton-seed meal.
6 swine receiving wood ashes and iron sulphate with cotton-seed meal.

All lots, except where only one individual in the lot, had some individuals in them that were in better condition than others but at the time of slaughter there was as great a difference between the individuals of each lot as between those of different lots.

As to the lesions found, all individuals showed slight congestion and some edema of portions of the lungs, but these were not more marked in one lot than another.

We have had opportunity upon several occasions to compare the more recent methods of applying the tuberculin test to cattle. These methods are the so-called ophthalmic (eye test) and intradermal (skin test), both of which we have found very reliable and especially applicable in retesting suspicious animals.

The agglutination test and the compliment fixation test have been applied to samples of blood from a number of animals suspected of suffering from infectious diseases.

Infectious abortion of cattle was recognized by these tests in three out of four dairy herds tested.

A number of samples of suspected poisonous feeds and plants were received for examination. The yellow jasmine was found to be the cause of death of a number of cattle.

Several specimens of animal parasites and of diseased tissues were examined and identified.

Samples of altered milk were received and examined to detect the character and cause of trouble.

The usual number of enquiries of diseases of animals in general have been replied to.

A number of cases of lameness and other minor forms of trouble among the Station live stock have been looked after.

We should like to give due credit to Dr. J. I. Handley of the Veterinary Department of the College for materially aiding us in a large part of the laboratory work. Respectfully submitted.

G. A. ROBERTS,
*Veterinarian.*

## REPORT OF THE POULTRY DIVISION.

Mr. B. W. Kilgore, *Director.*

Dear Sir: I submit herewith a report of the Poultry Division for the past two years:

After taking charge upon the resignation of Mr. Jeffrey the same lines of experimental work were carried out as laid down by him. These consisted chiefly of feeding work to determine further the availibility of cotton-seed meal as a substitute for beef scrap. This continued for six months at which time the results indicated that cotton-seed might be a source of protein but the inference from these tests is that bone meal is more of a source of protein than has been heretofore admitted. The palatability of cotton-seed meal limits its use because the fowls cannot be induced to eat enough to properly balance their rations, hence something else must be substituted, either wholly or in part, and bone meal on account of its cheapness is suggested. Where bone meal was fed the fowls produced eggs more cheaply than where cotton-seed meal alone was the source of protein.

These experiments were necessarily discontinued early in 1913 owing to the removal of that part of the poultry plant situated on the lands of the North Carolina Agricultural Society. The removal required most of the appropriations for poultry work, also left the plant badly handicapped as regards equipment for experimental work.

Since then, however, the plant is so straightened out and arranged that with an appropriation of $10,000 from both the College and the Station in equal parts ($5,000 each), good work could be done with the present site, and it is earnestly hoped that the next Legislature will see fit to vote the funds for same.

During the past season the same demand for breeding stock and eggs was manifested, many persons duplicating orders of previous seasons; showing in what esteem the stock of the Experiment Station is held. This is true not only of North Carolina but adjoining States as well, stock and eggs having been sold in other States to equal the amount sold locally.

This looks well for the poultry interests of North Carolina, showing the need of continued work in poultry husbandry, and I would respectfully suggest that as I shall sever my connection with this institution on September first, that the services of an experimenter of the first rank be secured and that a line of original investigation be carried on that will be a credit, not only to the institution but the State and United States as well. No State is better adapted to poultry raising than North Carolina and nothing will do more to advertise her advantages and opportunities in regard to poultry than a good line of experiments, the results of which are published with some regularity.

Respectfully submitted,

Thos. H. Taylor, *Poultryman.*

## REPORT OF DIVISION OF PLANT PATHOLOGY AND BACTERIOLOGY.

I submit herewith a report of the work of the Division of Plant Pathology and Bacteriology for the biennial period ending June 30, 1914.

During this period Mr. J. R. Winston served as assistant plant pathologist from July, 1912, to July, 1913. He was succeeded by Mr. R. O. Cromwell who took up the work in September, 1913. In the position of assistant bacteriologist the following have served: J. B. Stansel to September 1, 1912; R. C. Packard, September 1, 1912, to April 1, 1913; W. C. Norton, April, 1913, to the present time.

The soil nitrification studies have been in coöperation with the Division of Chemistry and have been mainly a study of the capabilities for nitrification in certain fertilizer experiment plats that have had contrasting manurial treatments and a definite crop rotation for a series of years. A report on this work is submitted for publication elsewhere in this report.

Work on the lettuce *Sclerotinia* wilt or drop disease has included an inquiry into the causes for the failure in certain instances of the sanitation method of control, a study of the modes of dissemination of the fungus, and a comparison of the lettuce fungus with a species of *Sclerotinia* attacking alfalfa and clovers.

Certain root diseases of apple are being investigated. Imperfectly understood points in the life histories of the commonly destructive apple diseases are being worked out.

The work on cabbage yellowsides has taken largely the direction of securing cabbage types resistant to the disease.

Work on the control of the bacterial wilt of tobacco continues in coöperation with the Bureau of Plant Industry of the United States Department of Agriculture, and is largely at the special experiment farm at Creedmoor, N. C. Laboratory studies on the life history of the organism are being made. Some attention is being given to its relationship to the tomato as a host. The occurrence of the disease on the peanut is reported elsewhere in this report.

The breeding work with the wilt-resistant variety of watermelon is continued for greater toughness of rind. Seed has been sent out during the two past seasons for testing by growers in various parts of the State on wilt infested land. The melon has given very general satisfaction in these tests. A striking case of seed dissemination of this wilt disease was investigated in 1912, and an account of it is given elsewhere in this report.

The spraying experiments with late crop Irish potatoes are being conducted at the Buncombe Test Farm, and are planned to run for a term of years.

Cotton anthracnose work is conducted at the West Raleigh and Edgecombe Farms. It includes studies regarding the resistance of certain

cotton varieties to the disease, a comparison of virulence in various strains of the parasite, the testing of methods of control, and the longevity of the organism in cotton seed products.

In coöperation with the United States Department of Agriculture and the North Carolina State Forester the chestnut belt in this State was scouted over in a search for the chestnut bark disease or blight. Mr. S. C. Bruner was detailed by the Bureau of Plant Industry for such work and for certain laboratory studies on the blight fungus under the direction of this Division for a period of some fourteen months. The chestnut blight was found in June, 1912, in a nursery in Guilford County and in a chestnut grove in the vicinity. The infected trees have been destroyed, and it is believed that the disease is under control at this point. The disease is advancing across Virginia and may be expected to enter our State from this quarter in the near future.

The Plant Disease Survey has been continued along the usual lines in coöperation with the United States Bureau of Plant Industry.

Numerous inquiries about the identity and control of crop diseases have been answered. Whenever it has been possible members of the staff have attended gatherings of farmers and of teachers for the purpose of giving out information about crop diseases and of keeping in touch with the problems that demand attention in this State.

Respectfully submitted,

H. R. Fulton,

*Chief, Plant Pathologist and Bacteriologist.*

## REPORT OF FARM DEMONSTRATION WORK.

There are two divisions of Farmers' Coöperative Demonstration Work. One for farmers and farm boys, and the other for farm women and girls. The latter division is under the supervision of Mrs. Jane S. McKimmon.

### ORGANIZATION AND DISTRIBUTION OF WORK.

Demonstration Work for men and boys consists of a State Agent, an Assistant State Agent, who had direct supervision of Boys' Club Work, three District Agents and seventy County or Local Agents.

The work was carried on in sixty-three counties, there being two agents working only half time in seven of the counties. Eight of the agents were negroes.

Our record shows that during the year we had on our rolls 4,052 demonstrators who conducted 4,966 demonstrations on their farms. There were enlisted 4,839 farmers called coöperators who followed the methods without direct supervision.

### OBJECT OF THE WORK.

The object and ultimate aims of the work is the building of a greater civilization in the State through better farming which will produce more money with which to build a great nation in any State where the great majority of the people are engaged in agricultural pursuits. Civilization is directly dependent on the earning capacity of the masses of its people, hence the necessity for better farming.

Better agricultural methods are taught mainly through practical object lessons or field demonstration in the growing of crops, animals, etc., by the best known methods put in to practice. These object lessons teach the most skeptical, backward farmers, because they cannot doubt what they see with their own eyes, and what reliable neighbors give them in the way of facts and figures kept as records of the work done.

At first the work started in a very simple way, mainly with the growing of corn, because that crop had been so largely neglected, and because there was so much corn being shipped into the State. The work during the seven years of its existence has advanced rapidly, and embraces almost every feature of farm work. A brief outline of the work is given under the headings as shown below.

### SOIL FERTILITY.

No system of agriculture can be permanently successful that leaves out the consideration of the fertility of the soil. The important things that should be given attention in the work are deep plowing, and the addition of organic matter, through the turning under of leguminous crops, and the use of barn yard manures. These two things, with proper drainage or terracing, whichever be necessary, are the things which

are being taught for the building up of the soil. In numerous cases a doubling of the depth of plowing of the stiffer soils have doubled the yield of the following crops without an additional amount of fertilizers. The planting of both summer and winter legumes are demonstrated with for the purpose of gathering nitrogen from the air and getting humus into the soil at the same time.

### WINTER COVER CROPS.

During the fall of 1914 a strenuous effort was made to greatly increase the amount of cover crops planted. This resulted in a direct increase as follows: 32,510 acres of clover; 4,240 acres of grasses; 12,987 acres of rye, vetch, rape and small grains. This is a total of over 50,000 acres, which at the reasonable valuation of $10 per acre was worth over $500,000 to the State.

### ROTATION OF CROPS.

We are actively advocating a definite and suitable system of rotation of crops for every farmer. We have records of 1,273 rotation systems started by demonstration agents during the year. These embrace over 18,000 acres. We expect, sooner or later, for every farmer we come in contact with to adopt some system of rotation of crops.

### FIELD CROPS.

During the year there were 2,896 acres of corn and 491 acres of cotton used as demonstration for teaching the best known methods of agriculture. The average yield of corn for this acreage was 45 bushels per acre, or more than twice the average yield of the State at large. Careful records, kept by the farmers themselves who grew the crops, show that this corn was grown for about 25 cents per bushel. With cotton, the average yield was about 1,200 pounds of seed cotton per acre, or about 50 per cent greater than the average yield of the State. There is no way of knowing the exact number of acres farmed indirectly by demonstration methods, because the methods spread from one farm to another without our having knowledge of such extension. Also a man often agrees to farm a few acres under our supervision, and then follows the same methods on many acres, or perhaps his whole farm. A fair estimate, however, of county agents directly in charge of the work places the average at about 200,000 acres.

### SEED SELECTION.

The matter of improved seed being of such great importance, that feature of farm work has been given due attention. Records show that 5,730 farmers were induced to select their seed in the field. They are taught also how to judge ears of corn, how to make seed tests for germination, and how to grow their own seed corn. This will add to the increased yields of crops.

### LIVE STOCK WORK.

We need more and better live stock in the State. We are giving this feature due attention. During the year we have succeeded in bringing into the State the following live stock of pure blooded types, mainly for breeding purposes: 51 stallions, 112 mares, 80 bulls, 240 cows, 1,031 sheep and hogs, or a total of 1,514 animals.

While we have advised the purchase of heavy work stock, we have also stressed the importance of growing our own work stock. We find that 1,291 heavy horses and mules have been purchased in demonstration territory during the year.

### DAIRY WORK.

The following figures give a fairly correct idea of what was done in the State in building up dairy work:

| | |
|---|---|
| Dairy demonstrations | 643 |
| Dairies established | 83 |
| Cows in above dairies | 418 |
| Dairy cows purchased | 322 |
| Cream separators purchased | 350 |
| Cows tested for profitableness | 720 |

### BEEF CATTLE.

We are assisting in the matter of getting and growing more beef. During the year we had 108 farmers demonstrating the best methods of growing beef. We have started 37 beef herds.

### HOGS.

Under the present conditions, swine growing, properly conducted, is probably the most profitable form of live stock production, because the animals multiply and come to maturity rapidly. It is expensive to grow pork on corn alone. We have urged the matter of making permanent and temporary pastures for hogs. During the year we had 90 farmers grazing 159 hogs in demonstration work. We started 676 hog pastures with 1,119 acres.

### POULTRY.

There is no more important part of the farm investment than that in poultry, considering the small amount needed for starting the business, and the quickness and frequency of returns. There is ample market for an immense and profitable increase in poultry growing, provided it is grown economically and the wants of the market catered to. To help this matter, we had 200 poultry demonstrators during the year with 2,257 birds. Thirty-four farmers were induced to produce non-fertile eggs. Altogether there were produced 1,200 chickens and 12,000 eggs in the work.

PASTURES.

During the year demonstration workers have started 376 permanent pastures with 3,850 acres. Over 500 gullied, or otherwise unprofitable pastures, have been renovated, put in suitable grasses and made profitable. We expect to urge this matter strenuously for the next few years.

ORCHARDS.

We are now giving the matter of orchards some attention. During the year we had 204 farmers doing demonstration work in orcharding. We inspected 398 orchards; sprayed 148; pruned 219; planted 668; supervised 120, or altogether 1,553 orchards. Advice was given as to proper treatment for the various diseases and insect pests which were found to exist.

GARDENS.

We have induced over 400 farmers to plant gardens and 110 to improve gardens. As a rule farmers should get a great deal more from their gardens than they are doing at present. We are trying to have them demonstrate that the garden is the most profitable piece of land of its size on the farm.

FARM MANURES.

We have advocated the saving of all animal manures possible. We advise the use of some form of phosphate for a better balanced plant food. We have succeeded in having 2,342 farmers take better care of their manure, mainly by better sheltering, better bedding, prevention of leaching and hauling out promptly and spreading on the fields, especially where grass or some other crops are growing.

FARM MACHINERY.

There is no way of knowing the full extent of the influence of demonstration work in getting better machinery on the farms. We have records of 3,276 farmers who have purchased better machinery at our suggestion. Numbers of others have been influenced indirectly.

HOUSEHOLD EQUIPMENT.

As a result of making more money on the farms, farmers through our advice have been induced to get water, light, or telephone systems installed in 271 homes. These matters will rapidly increase as farmers become able to have them.

STUMPS, TERRACES AND DRAINAGE.

These things are of much importance. During the year demonstration agents have succeeded in having stumps removed from 2,195 acres. The number of stumps removed was over 200,000.

In the western half of the State, a number of county agents have

given considerable attention to terracing. They have built altogether 1,236 terraces affecting over 5,000 acres of land.

In the eastern part of the State drainage is of importance. During the year agents have established 103 drainage systems on as many farms, thereby draining over a thousand acres. The increased yields of crops on these demonstration fields will have a far-reaching effect in the matter. This work was all tile drainage. Over 4,000 acres have been drained as demonstration work by the use of ditches, planks, poles, etc.

### CO-OPERATIVE BUYING AND SELLING.

The farmer needs to buy as cheaply as possible, and also needs a good profitable market for the disposing of his surplus crops. As a rule farmers have not given the matter of buying and selling as much attention as they should. The demonstration work started coöperative buying and selling organizations about a year ago. Through these organizations, there has been purchased 1,857 tons of phosphates, lime and other fertilizing materials, feed and seeds. This saved the farmers probably $10,000.

Most farmers should have surplus crops for sale, disposing of them at profitable prices. Under the instruction of demonstration work, farmers have sold coöperatively cotton, grain, tobacco, peanuts and truck crops to the extent of saving over $50,000.

### BOYS' CLUB WORK.

The junior part of demonstration work is that for boys and girls. These clubs have been very popular, and also very successful and interesting. The County agents enrolled during the year over 5,000 boys in Corn Club Work. They were taught the same methods in corn growing as were the grown-up farmers. Their average yield of corn per acre was 58 bushels at a cost of 46 cents per bushel.

Poultry Club Work was started one year ago. This is for both boys and girls. Within the last six months Pig Clubs have been started. The object of this work is for the production of much needed pork through the use of better blooded animals and the better feeding, pasturage, and care.

### COUNTY FAIRS.

County Fairs are worth much by way of diversion for farming people. They also stimulate better methods of farming and coöperation. During the year we have been instrumental in starting 32 County Fairs without much loss of time to other features of the work.

### MEETINGS.

As a rule demonstration agents attend all public meetings in reach that are of any consequence. During the year agents have held 855 public meetings with an attendance of 51,972 people. Field meetings

are such as are held on the farm or demonstration farm with some special object in view in regard to the planting, cultivation, etc., of the crop at that time. Ordinarily not over 25 to 30 people assemble at these gatherings. During the year agents have held 333 field meetings with an attendance of 8,791 farmers. They have also visited 1,763 schools with an attendance of 22,143. At these places they have taught better methods of farming, better methods of living such as sanitation, home conveniences, food values, etc. In these meetings they have reached a total of 64,727 people.

### VISITS, INTERVIEWS, TRAVEL, ETC.

During the year demonstration agents have visited 20,912 demonstrators, 8,473 coöperators, 17,676 other farmers, 3,852 club members, or altogether including the above meetings, they have talked to 115,641 farm people. In doing this work they have traveled 40,482 miles by rail and 130,416 miles by team or otherwise. This makes a total of 170,734 miles traveled.

Respectfully submitted,

C. R. Hudson,
*Chief, Demonstration Work.*

## RECEIPTS AND EXPENSES.

### THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
in account with
THE UNITED STATES APPROPRIATIONS, 1912-1913.

| DR. | Hatch Fund. | Adams Fund. |
|---|---|---|
| To Receipts from the Treasurer of the United States, as per appropriations for fiscal year ended June 30, 1913, under Acts of Congress approved March 2, 1887 (Hatch Fund) and March 16, 1906 (Adams Fund) | $15,000.00 | $15,000.00 |
| **CR.** | | |
| Salaries | $ 7,187.45 | $11,340.17 |
| Labor | 2,782.60 | 1,683.48 |
| Postage and Stationery | 603.07 | 246.79 |
| Freight and Express | 262.05 | 52.80 |
| Heat, Light, Water and Power | 122.54 | 194.44 |
| Chemicals and Laboratory Supplies | 21.93 | 425.66 |
| Seeds, Plants and Sundry Supplies | 726.91 | 296.80 |
| Feeding Stuffs | 1,662.25 | 316.67 |
| Library | 205.05 | |
| Tools, Implements and Appliances | 402.39 | |
| Scientific Apparatus and Specimens | | 156.01 |
| Live Stock | 199.91 | 92.25 |
| Traveling Expenses | 333.50 | 97.11 |
| Contingent Expenses | 24.00 | |
| Buildings and Land | 466.35 | 97.82 |
| Total | $15,000.00 | $15,000.00 |

*Supplemental Statement.*

### THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION.
in account with
SALES OF FARM PRODUCTS AND MISCELLANEOUS RECEIPTS FOR THE FISCAL YEAR ENDED JUNE 30, 1913.

| DR. | |
|---|---|
| To balance on hand July 1, 1912 | $3,981.29 |
| Receipts from other sources than the United States for the year ended June 30, 1913 | 5,103.81 |
| Total | $9,085.10 |
| **CR.** | |
| Salaries | $ 223.33 |
| Labor | 638.50 |
| Postage and Stationery | 72.45 |
| Freight and Express | 5.53 |
| Heat, Light, Water and Power | 270.92 |
| Chemicals and Laboratory Supplies | 48.40 |
| Seeds, Plants and Sundry Supplies | 139.95 |
| Fertilizers | 1,692.90 |
| Feeding Stuffs | 957.33 |
| Library | 229.10 |
| Tools, Machinery and Appliances | 102.68 |
| Furniture and Fixtures | 60.41 |
| Scientific Apparatus and Specimens | 76.20 |
| Live Stock | 2,171.95 |
| Traveling Expenses | 86.52 |
| Contingent Expenses | 19.71 |
| Buildings and Land | 819.57 $7,615.45 |
| Balance in Commercial National Bank June 30, 1913 | $1,469.65 |
| Total | $9,085.10 |

We, the undersigned, duly appointed Auditors of the corporation, do hereby certify that we have examined the books and accounts of the North Carolina Experiment Station for the fiscal year ending June 30, 1913; that we have found the same well kept and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to have been $30,000, and the corresponding disbursements $30,000; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving nothing.

And we further certify that the expenditures have been solely for the purposes set forth in the Acts of Congress, approved March 2, 1887, and March 16, 1906.

(Signed) W. E. Daniel,
(SEAL) M. B. Stickley,
W. B. Cooper,
*Auditors.*

Attest: A. F. Bowen,
*Custodian.*

We, the undersigned, duly appointed Auditors of the corporation, do hereby certify that we have examined the books and accounts of the North Carolina Experiment Station for the fiscal year ending June 30, 1914; that we have found the same well kept and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to have been $30,000, and the corresponding disbursements $30,000; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving nothing.

And we further certify that the expenditures have been solely for the purposes set forth in the Acts of Congress, approved March 2, 1887, and March 16, 1906.

(Signed) W. H. Ragan,
(SEAL) T. T. Thorne,
*Auditors.*

Attest: A. F. Bowen,
*Custodian.*

THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
in account with
The United States Appropriations, 1913-1914.

| Dr. | Hatch Fund. | Adams Fund. |
|---|---|---|
| To Receipts from the Treasurer of the United States, as per appropriations for fiscal year ended June 30, 1914, under Acts of Congress approved March 2, 1887 (Hatch Fund), and March 16, 1906 (Adams Fund) | $15,000.00 | $15,000.00 |
| **Cr.** | | |
| Salaries | $ 7,148.31 | $13,736.00 |
| Labor | 3,922.55 | 410.81 |
| Publications | 104.25 | |
| Postage and Stationery | 424.57 | 110.16 |
| Freight and Express | 345.97 | |
| Heat, Light, Water and Power | 128.72 | 119.05 |
| Chemicals and Laboratory Supplies | 21.25 | 413.62 |
| Fertilizers | 1,103.97 | |
| Feeding Stuffs | 952.22 | |
| Furniture and Fixtures | 112.00 | |
| Scientific Apparatus and Specimens | 65.81 | 210.36 |
| Live Stock | 371.38 | |
| Traveling Expenses | 279.00 | |
| Contingent Expenses | 20.00 | |
| Total | $15,000.00 | $15,000.00 |

*Supplemental Statement.*

## THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

in account with

FARM AND MISCELLANEOUS RECEIPTS, 1913-1914.

DR.

| | | |
|---|---|---|
| Balance in Bank June 30, 1913 | | $ 1,469.65 |
| Receipts from other sources than the United States for the year ended June 30, 1914 | | 11,774.35 |
| Borrowed from Bank (less discount) | | 4,950.00 |
| | | $18,194.00 |

CR.

| | | |
|---|---|---|
| Salaries | $ 210.00 | |
| Labor | 1,309.43 | |
| Postage and Stationery | 5.45 | |
| Freight and Express | 74.80 | |
| Heat, Light, Water and Power | 26.60 | |
| Chemicals and Laboratory Supplies | 4.95 | |
| Seeds, Plants and Sundry Supplies | 700.47 | |
| Fertilizers | 823.00 | |
| Feeding Stuffs | 2,690.15 | |
| Library | 358.15 | |
| Tools, Machinery and Appliances | 415.88 | |
| Live Stock | 4,486.60 | |
| Traveling Expenses | 42.38 | |
| Contingent Expenses | 151.04 | |
| Payment to Bank for money borrowed | 4,950.00 | 5,101.04 |
| Buildings and Land | | 338.77 |
| | | $16,587.67 |
| Balance in Commercial National Bank June 30, 1914 | | 1,606.33 |
| Total | | $18,194.00 |

## SCIENTIFIC PAPERS

### A DISEASE OF THE PEANUT CAUSED BY BACTERIUM SOLANACEARUM.

H. R. Fulton and J. R. Winston.

The peanut crop has long been regarded as remarkably free from fungous diseases. Leaf-spot occurs almost universally on the older plants, but does not often cause serious damage. The disease here discussed affects tobacco, Irish potato, tomato, eggplant and peppers as well as peanuts, and has the capability of seriously curtailing production of these crops and of lessening the agricultural value of lands wherever it becomes established.

Fig. 1. A field of Spanish peanuts showing about fifteen per cent loss from bacterial wilt. Note the affected plant by the hat on the left.

In August, 1912, peanuts (*Arachnis hypogaea*) of the Spanish variety growing in Granville County, North Carolina, on soil known to be infected with *Bacterium solanacearum* (Erw. Sm.), were observed to be dying to the extent of 15 per cent of the planting. Examination of stems and roots of the affected peanut plants showed discoloration and disorganization of tissues closely similar to those characteristic of Granville Wilt of tobacco. The newly affected parts contained numerous bacteria. Pure cultures were obtained from which both young and old peanut plants were successfully inoculated by stem punctures on several occasions, the disease induced being similar to that observed in the

field. The organism was reisolated from such artificially infected plants, and this culture again used for infecting the peanut. Young and old tobacco plants were inoculated by stem punctures with the original

FIG. 2. A peanut plant affected with bacterial wilt. Note the dried condition of the foliage.

cultures from peanut, with the production of disease similar in all respects to Granville Wilt of tobacco, and the typical organism was reisolated from these artificially infected tobacco plants. Cultures from naturally infected tobacco and pepper plants produced the disease in peanut.

Cultures of three strains of the bacterium from peanut were compared with cultures from tobacco and from pepper on various media, such as potato agar, nutrient gelatin, potato strips, peptone broth, glucose broth, beef broth, potato broth, milk and litmus milk. The cultural features on these several media were similar for all the strains tested, and agreed with the original descriptions for *B. solanacearum.*

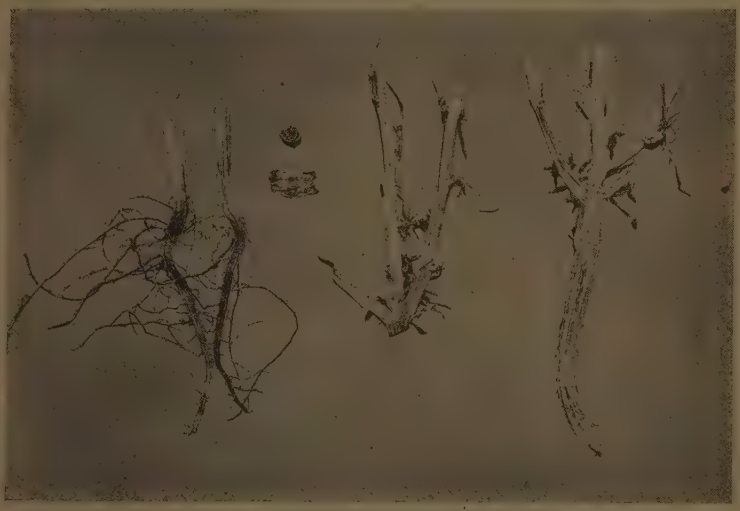

Fig. 3. Roots and stems of peanut plants affected with bacterial wilt. Note the discoloration of wood in the sections.

In size and shape, and in reaction to the ordinary strains these several strains agreed with *B. solanacearum.*

These facts lead to the conclusion that peanut is susceptible to attack by *B. solanacearum.*

The above work was completed before the writers were aware that J. A. Honing in his work on the same disease in Java had found that the peanut is a host for *B. solanacearum.*

Since the peanut is susceptible to this disease it should not be used in a crop rotation intended to control the disease on any of its other hosts. To do so would tend to defeat the purpose of such rotation, and the loss in the peanut crop would in itself be cause for abandoning such a plan on badly infested soil.

Growers of peanuts generally should familiarize themselves with this disease and its possibilities for damage so as to be on the lookout for it and take proper steps to prevent its becoming established in their soils. A general account of the disease is found in Bulletin 182 of The North Carolina Department of Agriculture, Raleigh, N. C. Tests in 1913

show that running varieties of peanuts are susceptible as well as the Spanish type. Particularly on the tomato the bacterial wilt is widely distributed in eastern North Carolina. In so far as can be judged, it is merely a question of time before it spreads from the gardens to fields of such important money crops as tobacco, peanuts and Irish potatoes. Any transfer of infected soil, whether by surface water, or on farm implements, or on the feet of men or stock, or clinging to the roots of transplanted plants of any sort, may spread the disease. Young infected plants of susceptible crops may carry it internally. Infected Irish potato tubers may serve as distributors.

The characteristic symptoms are a wilting or slower drying of the leaves involving part or in time all of the plant. The stems may show in external view elongated streaks that are dark and perhaps sunken. On cutting across affected stems, whether or not this external appearance is visible, dark areas are seen in the wood ring, and possibly in inner bark or central pith. On squeezing a cut stem a milky fluid can be forced out from the darkened areas, which is distinctly different from the normal clear watery sap. The root system shows a number of dead and blackened roots.

On peanuts this disease should be distinguished from a stem rot apparently caused by a species of *Rhizoctonia*. In this disease the bark

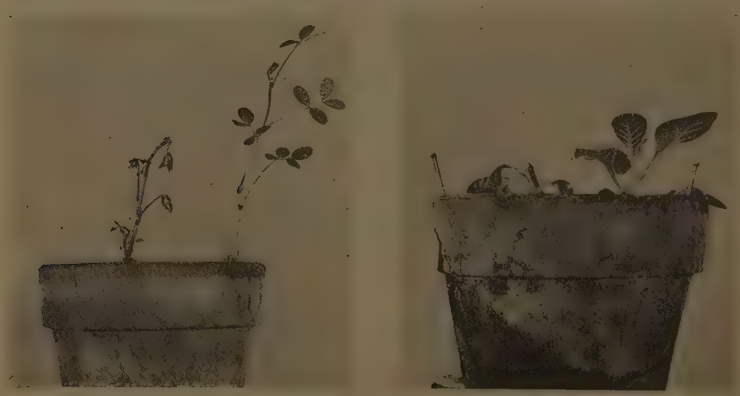

FIG. 4. Artificial infection of peanut and tobacco with the same strain of B. solanacearum obtained from peanut. The plant on the right in each pot was left uninoculated as a check.

is attacked from the outside at or a little below the surface of the ground. The surface becomes brown and sunken. Sometimes a weft of the cobwebby growth of the fungus can be distinguished on the stem. The roots may be involved to a varying extent. On plants that have made their full growth the bark is finally rotted away on the lower stems and the woody part may be weakened so that the stems break easily just below ground when they are pulled up. Very young plants may be

attacked even in the seedling stage. On these more succulent stems there may be a more rapid and complete rotting. In early stages the brown discolored areas are here quite conspicuous against the light green background. This disease is apparently serious only in rather moist places where there is a tendency to too great soil acidity. It seems likely that correction of these conditions by draining and liming, or by other means to the same end, together with a rotation of crops, will control this stem rot disease. Further studies on it are being conducted by this department.

## WATERMELON WILT SPREAD BY CONTAMINATED SEED.

H. R. FULTON AND J. R. WINSTON.

In August, 1912, complaint was received about a destructive watermelon disease appearing for the first time and in widespread fashion in one of the principal watermelon growing districts in the southern part of the State. The specimen submitted showed the disease to be the wilt caused by *Fusarium niveum*. The suddenness and extensiveness of the outbreak seemed to warrant special investigation, and so the junior writer was sent to the section. The following facts were ascertained:

The disease was on a number of farms for the first time. One variety, Eden Gem, was affected, and in each case the seed had been obtained from the same source, a grower whose farm was in another part of the county.

The wilt disease affected the previous year's crop of this grower, and had been in his locality for several years.

In one large planting from this seed there was practically a total loss. Thirty acres of the field was new ground.

In one case the infected seed had been used only in replanting and this in a part of the watermelon acreage on the place. The wilt developed where this seed had been used and nowhere else.

In one case adjoining fields were planted with infected seed, and with seed from another State. The former gave practically a total loss; the latter gave an excellent crop.

All of these field observations pointed to the one lot of seed, extensively sold in the locality, as the source of infection.

Some of the seed, left over from planting, was procured from one of the growers. Germination under controlled conditions in the laboratory gave seedlings with 85 per cent of the root systems stunted and evidently diseased. Microscopic examination showed a fungus that agreed with *E. niveum* in morphological characters and in mode of invasion.

Pure cultures were obtained and these were used on September 9 for inoculating two healthy volunteer watermelon plants out of doors. Parallel inoculations were made on September 12 with the affected tissue from the roots of the diseased seedlings. There was progressive but slow development of the fungus in the old inoculated plants, but there was no visible wilting up to the time of a killing frost, October 25. Microscopic examination showed progress of the fungus in the tracheids and characteristic discoloration for five or six inches, some of them being densely clogged with the mycelium. Eleven days after inoculation microscopic examination showed that the fungus well established in tracheids beyond the point of insertion.

There was still the question as to whether the seed were externally contaminated by adhering spores or were internally infected by the mycelium of the fungus. Seeds were washed in sterile distilled water, the washings concentrated and examined under the microscope. There

was an abundance of Fusarium spores agreeing with those of *F. niveum*. No quantitative estimate was made of them.

The infected seed, when disinfected externally, gave no diseased seedlings on germination.

Uncontaminated seed from another source were soaked in water containing *F. niveum* spores, dried, and later germinated, giving a 95 per cent of infection of the seedling roots.

It was found that *F. niveum* would grow well on the pulp of watermelon fruits, both when sterilized by heat and when fresh. It would also grow vigorously on the moist surfaces of freshly saved seed, producing spores over night.

Young and matured melon fruits from badly diseased vines were examined to determine whether the fungus might grow from affected vines through the fruit stems and so possibly reach the pulp and seed. No indication was found of this being the case.

As to the viability of the spores on the outside of the seed, tests eighteen months and two years after the seed were saved showed no apparent diminution in the percentage of diseased seedlings.

Since the source of danger is apparently merely external, soaking the seeds in a proper disinfectant ought to render them safe for planting. Tests were made to determine an effective and safe treatment with reference to the strength of the disinfectant and the length of soaking. Formaldehyde proved a desirable substance to use. Bichloride of mercury gave unpromising results because of impairment of germination.

The following table gives the results of one of the preliminary tests and illustrates the usefulness of formaldehyde. Each seed was germinated in a separate sterilized test tube.

| Number of Seeds | Condition | Treatment | Results in Ten Days | |
|---|---|---|---|---|
| | | | Germination | Infection |
| 100 | Contaminated | None | 85% | 84% |
| 100 | Contaminated | Formaldehyde, 1:400 for ½ hour | 88% | 2% |
| 100 | Contaminated | Formaldehyde, 1:200 for 1 hour | 92% | 0% |

Tests similar to the above were made repeatedly. It was generally the case that the formaldehyde treatment resulted in better germination and more vigorous seedlings than untreated lots, even when there was no *Fusarium* contamination; but greater strength than 1:200, and longer soakings than one hour had a tendency to retard the growth of the seedlings under laboratory conditions.

Not only were tests made in moist chambers and in test tubes, but series were carried through in pots and in out-door plantings. All results bore out the safety and efficiency of the formaldehyde treatment.

It is recommended that the seed be soaked for one-half hour in a 1 to 200 solution of formaldehyde. This would be one fluid ounce of formaldehyde in 15 pints of water. A tablespoonful is about half a fluid ounce, and it will be right to use one tablespoonful in one gallon of water. The formaldehyde (also known as formalin) can be bought at drug stores, and costs about 35 cents a pint in bottles sealed at the manufactory. It is important to get a guaranteed strength, because this substance, like ammonia, loses strength if not well stoppered. The dilution recommended above is for the full strength formaldehyde which is rated at 40 per cent. The seed may be planted as soon as dry after the treatment or they may be stored again for any length of time, but this must be in fresh or thoroughly disinfected containers.

There is a good chance for seed to become contaminated if saved from a field where the wilt disease exists. Old vines after dying from the disease develop spores of the fungus abundantly on their surface.

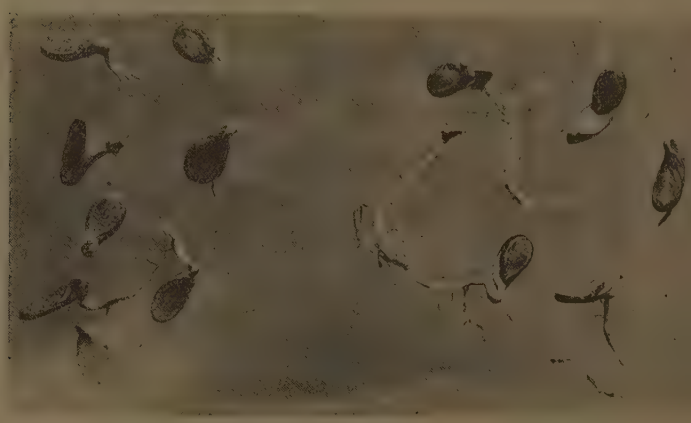

FIG. 1. Disinfection of wilt contaminated watermelon seed. Seed on the left untreated; note the diseased root systems. Those on the right soaked for 1½ hours in 1 to 200 formaldehyde solution.

It is an easy matter for a few of these to reach the fresh seed, either from the hands of workmen or from bits of trash. While the seeds are drying, the fungus may grow extensively in the moist mass and form a crop of spores abundant enough to thoroughly contaminate every seed in it.

It would be interesting to make an extensive study of samples of watermelon seeds from commercial seed dealers to determine the extent to which these are actually contaminated. Probably a very small proportion would be found so contaminated, otherwise watermelon wilt would be far more widely disseminated than it is. But it is gradually increasing its range, and doubtless the occasional lots of contaminated

seed that may get on the market are responsible for much of its spread to new localities.

Seed from fields where wilt does not occur would be safe. Commercial seed dealers should take every precaution to have their stocks come from such fields. Growers of commercial crops of watermelons should inquire into the conditions under which purchased seed has been grown. But the grower of melons, whether he plants a few rows or a hundred acres, can resort to the cheap and effective formaldehyde disinfection of his seed as an insurance against the introduction in this way of the wilt.

It must be remembered that this disease is easily spread by other means for short distances, as over a farm or throughout a community where it has been introduced. Manure is one of the most important of these means. It is a common practice to cut crab grass hay from melon fields late in the season, or to sow cowpeas between the rows of melons and later feed to stock. It is easy for portions of old diseased watermelon vines to get to the manure in the barns. In such material the fungus grows and reproduces itself luxuriantly and for an indefinite time. Such contaminated manure will introduce the fungus to the soil of any part of the farm where it is spread, but the effect will not be seen unless a susceptible crop is grown. The effective prevention of this mode of spread is one of the difficult features of control of this disease, as well as of the similar wilt diseases of other crops, such as cowpeas, cotton, tomatoes, etc.

Any transfer of infected soil will spread the disease. This may be on farm implements up and down the rows, or on wheels of wagons or on the feet of stock or men from one field to another. Surface water may transport the infective material.

Under ordinary conditions the fungus can be starved out of the soil by keeping watermelons off the land for a period of three to six years.

As soon as the disease appears, even to slightest degree, radical measures should be taken for its restriction and elimination. Otherwise it will steadily become more widespread each year until the profitable growing of watermelons will be prevented.

The United States Department of Agriculture and the North Carolina Agricultural Experiment Station have coöperatively bred a variety of watermelon that is highly resistant to the wilt disease. This seed has not yet been put on the general market because effort is being made to secure enough toughness of rind for shipping purposes. The variety is excellent for home use and local marketing. Persons who may be interested in giving this variety a test on wilt infested land will be supplied with a limited quantity of seed in so far as the supply permits.

BULLETIN 224 JANUARY, 1914

# NORTH CAROLINA

# AGRICULTURAL EXPERIMENT STATION

CONDUCTED JOINTLY BY THE

## STATE DEPARTMENT OF AGRICULTURE

AND THE

## COLLEGE OF AGRICULTURE AND MECHANIC ARTS

RALEIGH AND WEST RALEIGH

# TOP-WORKING SEEDLING PECAN TREES

BULLETINS OF THE STATION WILL BE SENT FREE TO CITIZENS OF THE STATE ON REQUEST

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# TOP-WORKING SEEDLING PECAN TREES

By W. N. HUTT, Horticulturist.

According to a census we have just completed, there are in this State upwards of 50,000 seedling pecan trees. These trees range in age from one to thirty years. Seventy-five per cent of them are of bearing age, but there is probably not 1 per cent of that number that are profitable bearing trees. In all parts of the pecan country experience has shown that seedling pecans are notably slow in coming into bearing, and some trees never bear at all. Those that do bear have nuts that are almost invariably small, thick-shelled, and of indifferent quality. In this respect, however, the pecan tree differs in no way from any of our other classes of fruits. No one would to-day be so foolish as to try to get a good peach or apple orchard by planting the seeds of these fruits; but this is just what a great many people have been trying to do with pecans.

This attempt to produce pecan orchards from seed has been the origin of the 50,000 trees noted in the census above. Now that we have these seedling pecan trees, are they of any value at all? Can we make anything out of them whatever, or must we cut them down and charge up the expenses to the account of experience, and start over again with standard varieties of budded and grafted trees? Years of time and quantities of money have been spent in producing these beautiful but comparatively valueless seedling trees. However, they are far from being a total loss, for in those deep roots and stalwart trunks and spreading branches there are latent possibilities in abundance. If by some magic power like that of Aladdin's wonderful lamp told of in the Tales of the Arabian Nights, we could transform these seedling trees in a single night to standard varieties, we would enrich every owner of pecan trees by hundreds of dollars, and the aggregate wealth of the State would be increased by millions.

For several years I have been in search of Aladdin's wonderful lamp to enlighten me how to effect this felicitous transformation. Like Aladdin's quest of old, the search has been long and wearisome and has led me a tedious road through many vexatious disappointments; but at last I have found the lamp! I have in my power the magic by which a worthless seedling pecan tree can be transformed into a productive standard variety. This magic talisman is simply **patch budding.**

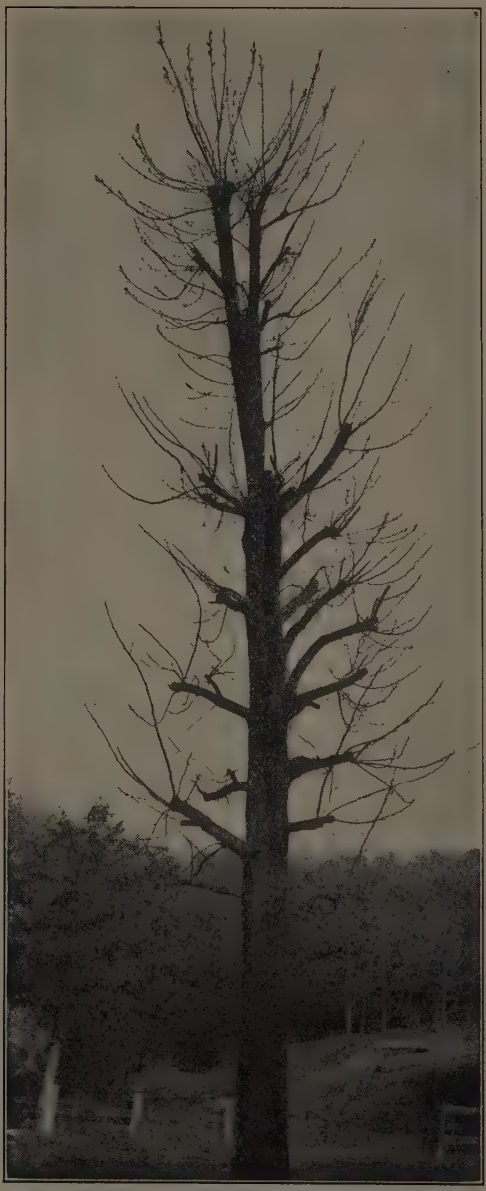

FIG. 1. Large seedling pecan tree being top-worked.

Every kind of budding is magical. Is it not wonderful to make a crab-apple tree produce Stayman or Grimes Golden apples or a quince bush produce luscious Duchess pears? Is it not strange that the sap from the same root can produce red apples on one branch, yellow ones on another, and russets on a third? How does it come that one twig can be made to produce sour apples and the next Paradise Sweets? Strange! Wonderful!! but True!!! It is all owing to the fact that the sap of a tree is a homogeneous substance and that it is the bud through which it passes that stamps the individuality upon it, whether it shall be a crab or a Grimes Golden. If we make all the buds of the tree of the Grimes character, the apples will all be Grimes Golden. In the same way, if we make all the buds on a pecan tree Stuarts or Schleys, there will be nuts to be gathered from that tree, and they will not be worthless scrub seedlings.

When I began my experiments in the top-working of seedling pecan trees I soon found that there were many things one could **not** do with pecan trees. I counted myself a successful propagator of apples, peaches, plums, grapes, and various other kinds of plants; but apple, peach, and general propagation methods failed to give success in the budding and grafting of pecans. I concluded the method must be all right, but that I should be more exact about my mechanical manipulations. I started out with the ordinary cleft graft commonly used for top-working most sorts of trees. I experimented in several different orchards and put in hundreds of cleft grafts. I took great pains to make my work as mechanically perfect as possible. All conditions of stock, cions, weather, etc., seemed to promise the highest degree of success. The result of that season's work was a world of disappointment, a lot of experience, and two living grafts. One of these latter, the result of my skill, was so effectively pruned that fall by the pecan girdler that my work for the season was practically a minus quantity in all but experience. The other living graft, which was put in by an assistant, is now a bearing Curtis tree, our only monument to the success of cleft grafting the pecan. Other propagators are said to be able to secure fair results with cleft grafting of pecans in certain localities; but from my experience, I am willing to aver that it cannot be done in this latitude.

Next followed a series of trials with shield budding, which is so uniformly successful with peach; but peach methods failed entirely with

pecans. Then followed a succession of trials with whip grafting, veneer grafting, bark grafting, and chip budding, all with a varyingly large percentage of failure and a uniformly small percentage of success. Some propagators in the South report fairly successful results in the chip budding of pecans, but my results with this method were largely of a negative character.

After persistent trials of all the known methods of budding and grafting, through the varying conditions of four successive seasons, I have narrowed the propagation of the pecan in North Carolina to one single method, namely, patch budding. This method has, year after year, given us the highest percentage of successful unions. The operation, illustrated by figures 1 to 10, is as follows:

### 1. HEADING BACK.

During the dormant period, which is, roughly speaking, from November 1st to March 1st, the seedling trees are cut back to stubs, the ends of which may be from 1 to 3 inches in diameter. Wounds larger than this size take years to heal and endanger the life of the tree. Large trees can be operated on as well as small seedlings, only one has to go higher up so as not to cut too large limbs. Figure 1 shows a seedling pecan tree 18 inches in diameter, which was stubbed back in the winter of 1911-12 and successfully budded the following summer. The result of this drastic heading back is a numerous growth of vigorous, rapidly growing shoots near the ends of the stubs, by which nature endeavors to heal over the wounds. The cambium in these vigorous, sappy shoots is in the most active condition possible; just the condition most suitable for the union of stock and cion. This optimum condition cannot be secured except by the forced growth as the result of the heading back. Our experiments, year after year, have shown that on the ordinary new shoots, even on active young seedling trees, the percentage of living buds was much less than on the forced shoots of the headed-back trees.

The different steps in the operation of patch budding are briefly as follows:

*First operation:* Making parallel cuts on stock. See figure 2.

*Second operation:* Making vertical cut to remove bark from stock. See figure 3.

*Third operation:* Loosening patch on stock. See figure 4.

*Fourth operation:* Making parallel cuts on cion. See figure 5.

*Fifth operation:* Making vertical cut to remove bud patch from cion. See figure 6.

*Sixth operation:* Taking bud off bud stick. See figure 7.

*Seventh operation:* Inserting bud on stock. See figure 8.

*Eighth operation:* Beginning the tie. See figure 9.

*Ninth operation:* Wrapping the bud. See figure 10.

*Tenth operation:* The completed operation. See figure 11.

The accompanying illustrations should make the method self-explanatory.

## KNIVES FOR PATCH BUDDING.

Two sorts of knives are used for patch budding; the double ones shown in figure 12, *b* and *c*, for making the parallel cuts and the ordinary budding knife, figure 12 *a*, for removing the patch.

## CAMBIUM.

Professor Bailey, in his Encyclopedia of Horticulture, says: "The ways and fashions of grafting are legion. There are as many ways as there are ways of whittling. The operator may fashion the union of stock and cion to suit himself if only he apply cambium to cambium, make a close joint and properly protect the work."

The fundamental basis of the whole science of grafting is cambium. What, then, is this important substance by means of which one plant may be made to live and grow and produce on the roots of another? If we strip off the bark of any actively growing, woody plant we will find just beneath a soft, colorless substance; this substance is cambium. It feels slimy to the touch, and if scraped with the finger nail a little doughy mass can be raised. As we examine it it will be seen to quickly darken to cream color, then to yellow, and finally to dark brown. A change has taken place in it in a few seconds, right under our eyes. When we first exposed it, it was living, active, and capable of building the most complicated of plant structures; now it is dead, inert, and impotent. If we examine the smallest portion of this doughy mass under a compound microscope we will find it not merely slime, but a highly organized tissue made up of countless minute cells, each with a delicate wall about it and containing a thickish liquid (protoplasm). The cambium cells are brick-shaped, and are placed end to end, with layer overlapping layer, like bricks in the wall of a building. The microscopic

FIG. 2. *First operation:* Making parallel cuts on stock.



FIG. 3. *Second operation:* Making vertical cut to remove bark from stock.

FIG. 4. *Third operation:* Loosening patch on stock.



FIG. 5. *Fourth operation:* Making parallel cuts on cion.

FIG. 6. *Fifth operation:* Making vertical cut to remove bud patch from bud stick.

FIG. 7. *Sixth operation:* Taking bud off bud stick.

FIG. 8. *Seventh operation:* Inserting bud on stock.



FIG. 9. *Eighth operation:* Beginning the tie.

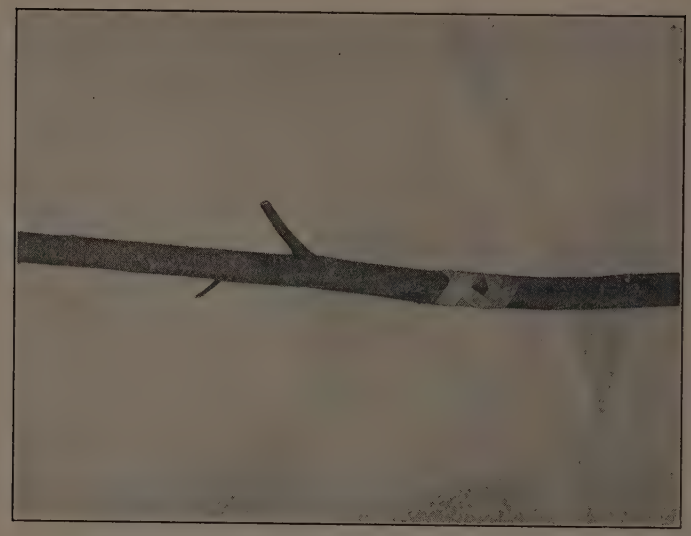

FIG. 11. The completed operation.

FIG. 10. *Ninth operation:* Wrapping the bud.

structure of cambium tissue gives us a clearer conception of its extreme delicacy. It is one of the most sensitive and delicate substances in all nature. Exposure to the air will kill it and completely destroy its functions in a few seconds. It is easily crushed by slight pressure and quickly killed by exposure to drying, frost, moisture, and sunlight. Nature shows her extreme care of it, for in making bark she has formed for the delicate cambium a perfect protective covering. Like the cambium, the bark is composed of cells, as in fact are all animal and vegetable structures. But the cells of the bark have thick walls of a tough, corky substance, and each cell contains air instead of protoplasm. The corkiness of the bark makes it an impervious, waterproof covering that does not allow the cambium to be dried out or to be washed by external moisture. The air in the bark cells being in a still condition, is a nonconductor of heat, and layer of bark overlapping layer, the cambium is completely covered with a dead-air blanket. This keeps it from being frozen in winter and from being overheated in summer, just as a dead-air space in the walls of a building protects from extremes of heat and cold. From this it is plain that nature takes great pains to cover and protect the delicate cambium from all external influences. This stands in striking contrast to the careless manner in which many propagators and planters handle the delicate parts of trees. It also explains why some budders get such a small percentage of living buds and planters so few living trees.

Cambium is the building material of plants, and without it growth is impossible. It covers every portion of the tree from the topmost terminal bud to the deepest root tip like a living blanket. During the growing season the cambium cells divide lengthwise, forming new cells. These divide again and grow, and new cells are formed, until by fall a complete mantle of bark covers the outer surface of the cambium, while within it has built up a solid layer of the woody structure of the tree. A few rows of cambium cells are left in an embryonic condition to carry on growth the following year. The cambium is thus the only tissue of the tree that retains from year to year the power of active growth. The layers of wood and bark, after performing their functions for a few seasons, gradually die and are overlapped by new layers; but the cambium remains living throughout the entire life of the tree, even if it be, as in the giant Redwoods, thousands of years.

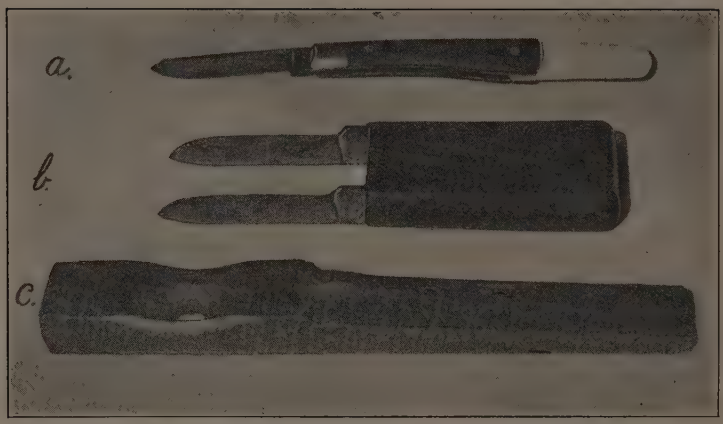


FIG. 12. Knives for patch budding.

Besides forming the regular wood of the tree, the cambium also grows out over cut places and builds in woody tissues that heal over the wounds. It is owing to this fact alone that budding and grafting are possible. The callus on cuttings and root grafts is another evidence of the same phenomenon, for the cambium of the roots of a tree is continuous and identical with that of the branches.

## THE STOCK.

The whole practice of successful grafting and budding is the proper handling of active cambium. The cambium is the cementing material that unites stock and cion, and unless there is active cambium there will be no union. It must be said here that no matter how great the future growth of the union, the cion never becomes truly united or fused with the stock. The cambium grows all over and around the cut parts and cements them together; but if the graft union be split open fifty years later, the dead wood of the original cion may be found of the original size and in the original position. Since, then, successful grafting depends on the union of the cambium of the stock with that of the cion, theoretically the best time for grafting and budding would be when the cambium is most active. Actual nursery practice shows that this is practically correct, at least as regards the stock.

The ideal stock for propagation purposes is the young seedling of one or two years growth. In such a stock all the tissues are new and fresh and working to their maximum capacity, and the cambium is in its most active condition. In top-working old trees it will be found that though the branches may appear vigorous, they are a long way from having anything like the active circulation found in small seedlings. Buds put in these branches would give a very small "live," while the same care on nursery seedlings could be counted on giving a high percentage of living buds. In top-working, therefore, it is found necessary, in order to get the cambium sufficiently active, to stub back the branches to mere pollards. This cutting back should be done in the winter or dormant season. The following growing season will see a dense growth of very vigorous shoots trying to repair the injury. See figure 1. These shoots are ideal stocks, for, on account of their having all the sap from the greater root of the mature tree, the cambium will be even more active than in the nursery seedling. Often when nursery seedlings are in partially dormant condition, owing to unfavorable weather or other con-

ditions, they may be forced into budding condition by slashing off part of the growth above where the buds are to be inserted. In our top-working experiments this fact was further emphasized by a windstorm which broke off many of the sappy shoots just above where the bud was put on. Every single one of these buds "took," though some others, just as carefully put on, failed. The success of all the buds on the wind-broken shoots was undoubtedly due to the forcing of the cambium growth just at the point where the bud was inserted.

### THE CION.

Although it is desirable to have the cambium of the stock in an active growing condition, it is quite the reverse with the cion. The reason of this is evident, for if the cion were active, it would soon exhaust its small supply of food and die before the union could be formed and it could get its permanent supply of nourishment from the root. It is desirable to have cions fresh and firm but in a quiescent condition until pushed into activity by the growth of the stock. If, on the other hand, the cions or buds become too dry the sap will not be able to revive them and no union will be made.

For patch budding, the buds may be cut from cions or bud sticks of the present or the past season's growth. Figure 13 shows a bud stick of the present season's growth from which the leaves have been cut. Such a bud stick cannot be obtained until July, for before that time the bark is so tender that it is impossible to get the bud patch off the stick without crushing it or peeling off the cuticle of the bark. The basal buds of the present season's growth (figure 13, a, a, a) make the best buds, because they are more mature and dormant than the buds above them, and as they have shed the leaf stalk, they can be tied in more easily and snugly than those with the thick, fleshy base of the leaf stalk attached. Some budders make a practice of cutting off the leaves ten days or two weeks before they commence budding and leaving the cions on the trees to ripen the buds and shed off the bases of the petioles. There is in this way no danger of the thick fleshy leaf base decaying under the wrap and souring and killing the buds.

Figure 14 shows budwood of the previous season's growth. This budwood can be cut during the winter and kept over in fresh dormant condition by being packed in damp sawdust and carried over in ordinary

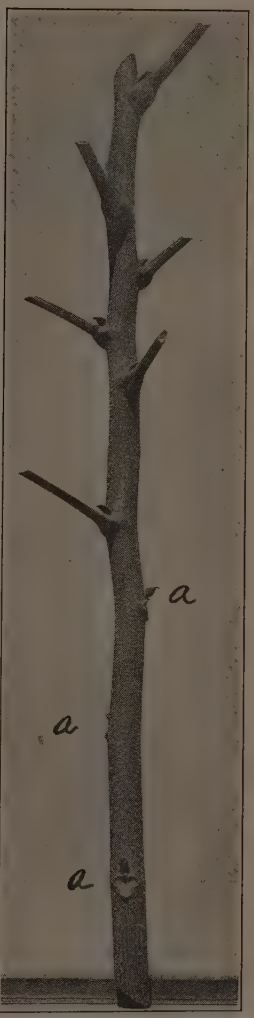


Fig. 13. Bud stick of present season's growth. Desirable buds at a, a, a.

cold storage or in a refrigerator. It will be ready for use in the spring as soon as the bark will slip on the stocks. By this method the budding season may be greatly extended and propagation started at least two months before any of the present season's buds will be sufficiently mature for use.

### THE KINDS OF BUDS TO SELECT.

As to the buds themselves, the most desirable are those at the base of the season's growth. See figure 13. These, though not large, are plump and fully mature. The bark is smoother and firmer about them than higher up the stem, and there is no leaf stalk to interfere with cutting them accurately and making a close fit and tie. These buds are dormant, and there is little danger of them pushing into growth in the fall and being cold hurt the following winter. For best success in patch budding it is not desirable to select very large, overdeveloped buds, or those that have grown so rapidly as to stand out on a little pedicel or basal stalk. In removing such a bud from the stick, the central column of the pedicel will often pull out and remain on the stick. Such a bud will almost invariably die. An observation of pecan buds in general will show that they are normally triple in form, the largest above and two smaller ones beneath it. The largest bud will grow first, but if anything happens to it, the next one will take its place.

### TYING IN THE BUDS.

A good deal of the success in patch budding depends on the tying-in of the buds. The cambium must be thoroughly protected if a union is to result. It is necessary to have some kind of tie that will retain the sap as well as exclude external moisture. After experimenting with different materials and methods, I have finally abandoned all except the waxed strip tie. This is made by dipping sheet cotton in pure liquid beeswax, and pressing out all extra wax. The cloth after dipping is formed into convenient sized rolls. From these rolls the cloth is torn at budding time into strips a quarter of an inch wide and from 8 to 10 inches long.

In tying in a bud, hold it firmly so that it will not slip, and begin at the top and bind it in very tightly with the waxed strip. Reverse the tie at the rear of the bud like a surgeon's bandage and cover the patch completely, leaving only the tip of the bud sticking out. The wax in the cloth will cause the tie to adhere sufficiently to the wood that no other

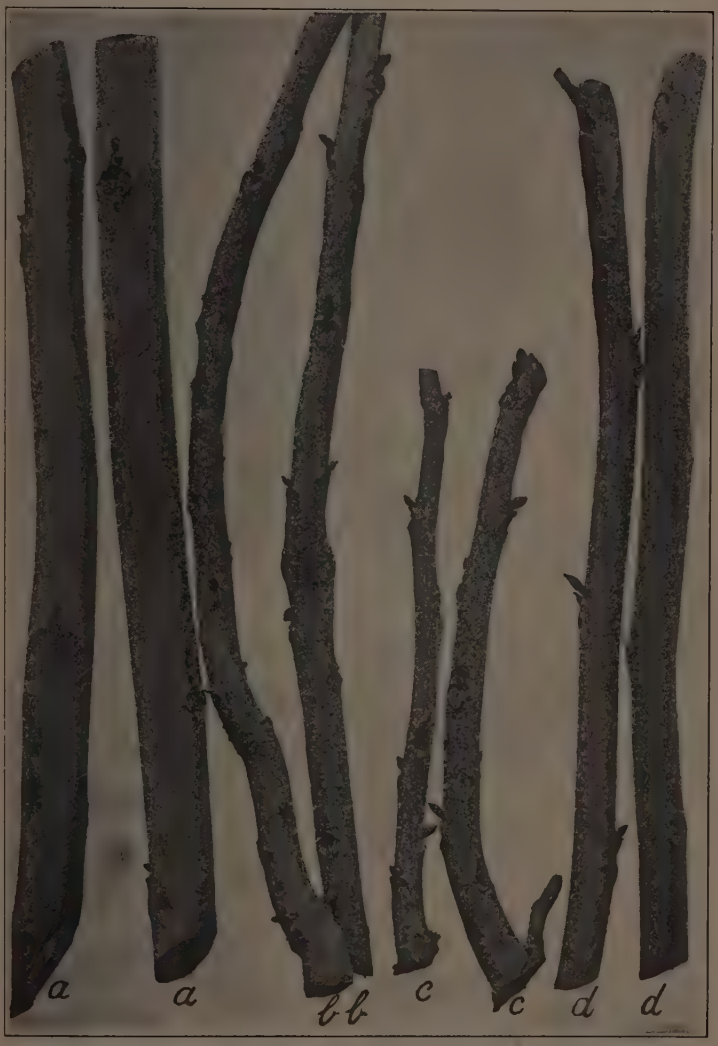


Fig. 14. Bud sticks: a, a, wood too old; b, b, showing buds of two seasons growth; c, c, bud wood too small: d, d, vigorous bud wood showing good buds.

ligature is required. In budding in the spring, when the flow of sap is very copious, it is well to tie in a small splinter about the size of a match just below the bud to drain off the excess sap. This will save many buds from being killed by souring of the sap. In two to three weeks time the tie should be loosened so that the rapid growth of the stock will not cause the tie to cut into the bark. Figure 15 shows a bud from which the tie has been removed.

### THE MECHANICS OF PATCH BUDDING.

After all has been said about cambium and stocks and cions and their relation to each other, there are still volumes to be written on the mechanics of pecan propagation. I do not want to scare any one off from trying, but if there is any plant more difficult to propagate than the pecan, I have not yet found it. Even experienced propagators of general nursery stock have given up pecan budding as a bad job. On the other hand, a novice or "pecan crank" who is handy with tools and has the patience to study out the causes of his failures, may acquire the skill to obtain almost a perfect "live" of buds. This all goes to show that extreme precision is the password in the mechanics of patch budding. In the first place, the knives should be of the finest quality, so that they will hold a clean, fine edge. All cuts should be made with accuracy and precision, so that there are no rough edges and bias corners. The number of living buds will, under ordinary circumstances, be in exact proportion to the accuracy with which the bud patch fits the place made for it on the stock. The experienced pecan budder as he takes the buds off the stick can tell whether or not they will grow. If he tears the bark in cutting the patch, he drops that bud and cuts another; if the bud patch splits, he discards it; if his fingers touch the cambium or the bud patch falls to the ground, he wastes no time with it, but cuts another and another until he gets the conditions perfect. There is little use in tying in any bud that does not fit perfectly. For this reason it is desirable to have the budstick as near the same diameter as the stock. The bud patches from thin or small cions have to be stretched to fit and generally give a poor "live"; likewise, the buds from the more or less ridged portion at the top of the budstick. The transfer of the bud patch should also be made quickly, so that the cambium will have the shortest possible exposure to the air.

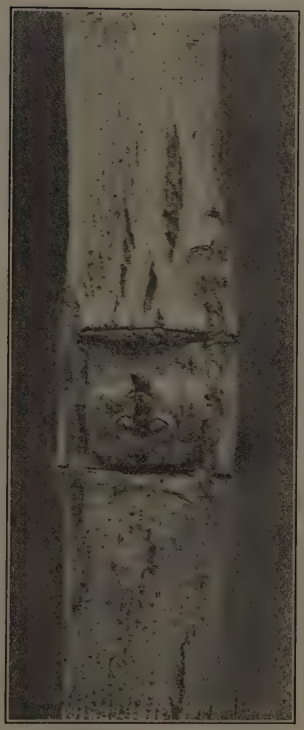

Fig. 15. Inserted bud with tie removed.

FIG. 16. Seedling grove stubbed back for top-working.

FIG. 17. A top-worked bearing pecan tree.

## AFTER TREATMENT.

The process of patch budding is not complete even after a good "live" of buds is secured. It still requires some judicious after-treatment to get them into good normal growth. On account of the drastic heading back the tree has received, practically every dormant bud will be forced into active growth. These will push out so vigorously in spring that if not held in check they will completely overgrow and crowd out the buds put in. Attention should be given during the early growing period to see that the buds put in have sufficient room for proper development. If all or too many of the seedling buds are rubbed off, the inserted buds will not be able to carry all of the heavy flow of sap, and so may be drowned and killed. On the other hand, the inserted buds may not start unless forced by the extra sap obtained by rubbing off a portion of the seedling buds. A good deal of horticultural judgment is required to adjust the proper balance between the seedling and the inserted buds so as to get the best development of the latter. When the inserted buds are able to carry all the sap of the tree, all seedling shoots should be cut out and attention directed towards forming the new growth into a strong, symmetrical top.

If conditions are favorable, there will generally be some nuts the second season. By the third year the transformation from the seedling to the named variety should be complete, and a good crop of high-class nuts should be expected.

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BULLETIN 225 FEBRUARY 1914

NORTH CAROLINA

# AGRICULTURAL EXPERIMENT STATION

OF THE

COLLEGE OF AGRICULTURE AND
MECHANIC ARTS

WEST RALEIGH

# HOW SHALL FARMERS ORGANIZE?

Bulletins of the Station Will be Sent Free to Citizens on Request

# THE NORTH CAROLINA
# AGRICULTURAL EXPERIMENT STATION

CONDUCTED JOINTLY BY THE

## STATE DEPARTMENT OF AGRICULTURE

AND THE

## COLLEGE OF AGRICULTURE AND MECHANIC ARTS

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## HOW SHALL FARMERS ORGANIZE?

*By Wm. R. Camp, Chief, Division of Markets.*

In every community some form of association of farmers should be formed for education in better methods of production and marketing. This does not mean that the farmers of each community should at once incorporate their organizations. Much can be acomplished by working together in voluntary associations, the yield increased, the standard of produce grown improved, and a knowledge of markets obtained. Practice in thinking together will bring about a class consciousness of mutual interests and an understanding of mutual problems. No individual could be expected to succeed in a business for which he had not prepared himself by a long apprenticeship. Collective business is a form of enterprise which the isolated life of farming has not prepared the grower to succeed in. Naturally farmers are suspicious of one another in the face of an undertaking of which they have little knowledge.

The individual prefers to do business in his own way rather than surrender his own habits in order to adopt a common method of procedure. Part of our political and religious faith has been liberty for the individual to do as he pleases so long as he does not injure others. Business in many lines, such as railroads and steel, has had to suffer great losses through cut-throat competition before coming together. The trust movement is strewn by the wreckage of small independent concerns.

Seventy-five per cent of the manufacturing business is now incorporated. Many of the corporations have consolidated into larger corporations. The corporation is the exception in agriculture. Manufacturers, skilled laborers and the farmers of many European countries have organized. But the farmers of the United States have the task of organization largely before them. Some manufacturers, while holding to the ownership of their independent plants, have organized joint sale or purchasing agencies. It is some such pool form of organization as this that the land-owning and farming classes of Europe have so successfully developed.

The farmers of a community must feel the necessity of working together before any movement for their organization can be expected to succeed. The evils of the existing conditions must be seen before a search for a remedy can be made. The grain growers of the Northwest found the elevator corporations, the railroads and the banks working together against the farming interests. The price of grain was so depressed they had to do something. The establishment of twenty-five hundred farmers' elevators in the grain belt states is testimony of their success. Through combined efforts a better treatment can be obtained from all other business organizations. Banks, railroads and middlemen organizations can be better utilized.

Without incorporating the farmers may come together and appoint

committees to look after different interests in the community. Such committees may send for mail order house catalogues, learn the retail prices of dry goods, shoes, groceries, seeds, fertilizers and farm machinery in other places, secure special prices upon large orders and make up such orders from the households of all those who have come together.

Some form of organization for the collective purchase of supplies may profitably be started in communities where cash prices are high, or where credit prices are much higher than cash prices. The purchase of goods on credit is often truly spoken of as one of the greatest curses of the South. Book credit is most extensive in those communities in which the crops come in only in one season of the year. In all such places farmers should organize to encourage collective purchases, to eliminate buying on credit, to encourage thrift, to limit purchases to the cash in hand and to make terms with the banks for reasonable credit.

Coöperation in providing security will help deliver the members of a community from the high cost of book credit. With advances from a bank better terms can be made for the members of an association, either at the local stores or with wholesale merchants. Under the existing system farmers obtain credit from the supply stores and the supply stores go to the banks for credit while they themselves carry the farmers. If farmers will coöperate to provide the banks with gilt-edge securities they may save themselves from five to a hundred per cent in the cost of credit. Going direct to the bank for credit instead of to the supply store means the elimination of one middleman.

A charter for incorporating a farmers' organization does not have to be obtanied for each community to have a committee to learn what prices are being paid for farm produce locally as compared to other places. A committee on grades should be established in every place where fruit, truck and cotton are marketed. Improved grades should mean better prices. If products are standardized the problem of grading in a community is made easier. The growing of standardized products and the grading of them according to accepted standards constitute the A B C of marketing. Common standards cannot be adopted without the members of a community working together for that end. A federation of local committees for the whole State of North Carolina could hope to call attention to the evils of grading and marketing and would be in a position to give effective support to any movement to obtain a more just system of grading between producers and buyers. These local vigilant committees should be the forerunners of a farmers' coöperative marketing organization in every community.

## Meeting for Incorporation

A temporary chairman and secretary should be elected at the first meeting. The advantages of incorporating a coöperative association should be discussed. It should be made clear that incorporation means that the members will not be liable for the debts of the association beyond the amount of the subscribed capital.

Before finally deciding to incorporate three or more should be ap-

pointed on a committee to canvass the section to see if a sufficient number are interested in becoming stockholders to warrant the formation of an incorporated association. The same committee should gather information as to the probable amount of business that may be done and as to the probable cost per unit of business transacted.

When the committee is ready to report a second meeting should be called. All of those especially interested should be invited to attend. If the committee reports that the number of those who may be expected to subscribe is ample and the business in prospect is sufficient, application should be made to the Secretary of State for a blank certificate of incorporation. This blank must be filled out in order to secure a charter for doing business as a corporation.

## Filling Out the Certificate of Incorporation

It is well to make the expressed objects for the formation of your organization sufficiently broad to include any possible line of business which you may at any time later wish to undertake. You will then be able to buy, sell or manufacture any products which may later seem advisable without going to the expense of getting a new charter.

The certificate of incorporation of the United Fruit Growers of Western North Carolina, North Wilkesboro, N. C., has a broad statement of the objects of a fruit growers' corporation, which may be taken as a good example for farmers in other lines. The objects for which this corporation is formed are stated as follows:

"To buy and sell fruits, vegetables, produce, meat, stock and all products of and necessities for western North Carolina, both fresh and manufactured; to erect, operate and maintain canning and packing factories, cider-vinegar generators, and commission houses; to manufacture and grow any and all products of western North Carolina; to erect, operate and maintain ice plants and cold storage, and to engage in such other business as pertains to the fruit and truck-growing industry of western North Carolina."

The amount of the authorized or maximum capital stock, as distinguished from the working capital, may be any sum from $5,000 to $100,000, or more. The shares better be made as small as $5 or $10 each so that the poorest farmer may take at least one share. The amount of funds, with which the association may begin business, may be large or small according to the nature of the business. The capital may be increased in the manner and to the amount the directors may determine as the need arises.

If the desire is to begin business on as small a scale as possible the amount of capital need not be large. If supplies are to be largely purchased upon orders which have been previously gathered together from the members, the expense may be apportioned to each member according to the amount of the purchases. In the case of the sale of products the organization may act as the agent of the growers at a fixed rate of commission, which shall cover all expenses. In this way it is possible to get along with a very small working capital. On the other hand, if the paid

in capital can be made larger than the actual necessities of equipment and operation the surplus may be deposited in a bank. This will help to establish the credit of the organization. If the members who have a credit standing with the bank will agree to be jointly responsible for all overdrafts up to a certain amount the bank may agree to honor them within these limits. Through this arrangement the amount of the working capital need not be so large.

## Suggested By-Laws for Co-operative Purchase and Sale Societies *

After the charter has been obtained the stockholders may proceed to make the by-laws which shall determine the method of conducting the business. We suggest the following form of by-laws which may be modified to suit the business to be organized.

### ARTICLE I.

#### Membership.

Section 1. The membership of the association shall be confined as far as possible to actual growers and agricultural land-owners. Not more than ten per cent of the stock shall be sold to those whose main interest is other than farming.

Sec. 2. All shares must, before issue, be registered on the books of the association, by being surrendered, and new ones issued in the name of the purchaser, who, by acceptance thereof, agrees to all the by-laws and rules of the asociation, including also all amendments that may be legally adopted, and thereby shall become a member of the company. No shares can be transferred until all claims of this company against the owner of such shares have been paid.

Sec. 3. If any member of the association desires to dispose of his share or shares, he shall first offer to sell the same to the company at market value; if the company decline to purchase, the member may find a purchaser acceptable to the company and have the same transferred to said purchaser on the books of the company in accordance with the rules. If a member removes from the territory and ceases to be a patron of the association and establishes a residence elsewhere, the board of directors shall purchase the share or shares owned by the said non-resident member. Sections two (2) and three (3) of this article shall be printed on each and every certificate of stock issued by the company.

Sec. 4. New members may be admitted by a majority vote of the association.

Sec. 5. The acceptance by a member of a stock certificate shall constitute a contract between such member and the company and assent of such stockholder to these by-laws and to any amendments which may be legally adopted.

Sec. 6. Each member shall be entitled to one vote only.

Sec. 7. No member shall be entitled to own more than ten per cent of the capital stock.

*These by-laws are largely based on a model of forms recommended by the Wisconsin State Board of Public Affairs, and upon the by-laws of the Catawba Co-operative Creamery Company.

## ARTICLE II.

### Board of Directors.

Section 1. The board of directors shall consist of.....members.

Sec. 2. They shall be elected by and from among the stockholders at the annual meeting and shall serve until their successors are duly elected and qualified. Of the directors elected upon completion of the organization, .....shall serve one year, .....two years, and..... three years. The regular term of office of the directors shall be three years. If vacancies occur in the board the same shall be filled by the remaining directors until the next annual election.

Immediately after the election of the directors the newly elected board of directors shall meet for organization and the election of officers.

Sec. 3. The board of directors shall have the management and control of the business of the corporation and shall employ such agents as they may deem advisable and fix the rate of compensation of all officers and employees.

Sec. 4. The board of directors shall audit the accounts of the association at least once every quarter.

Sec. 5. The board of directors shall meet on the first..... of each month and be subject to a call for special meetings at such times as the president or secretary may deem necessary.

Sec. 6. A majority of the directors shall constitute a quorum of the board.

Sec. 7. No member of the board of directors shall be allowed to vote on any question in which he may have any interest conflicting with that of the association.

## ARTICLE III.

### Officers.

Section 1. The officers of the corporation shall consist of president, vice-president, secretary and treasurer. The office of secretary and treasurer may be held by the same person. The officers shall be elected by the board of directors by a majority vote of the whole number of directors. The first elections shall be held immediately after the election of the board. Subsequent elections shall be held annually on the day of the regular meeting of the board next ensuing election, the day to be fixed by resolution of the board of directors.

Sec. 2. In case of death, resignation, or removal of any officer, the board shall elect his successor who shall hold office for the unexpired term.

Sec. 3. The president shall preside at all meetings of the association. He shall have power to call special meetings of the association whenever, in his judgment, the business of the association shall require it. He shall also, upon a written request of ten per cent of the stockholders or three members of the board of directors, call a special meeting.

Sec. 4. The vice-president shall perform the duties of the president when the latter is absent or unable to perform the duties of his office.

Sec. 5. The secretary shall keep a record of the proceedings of all meetings held by the stockholders of the company, and also of all meetings of the board of directors.

The secretary shall keep the accounts of the company and use such system for that purpose as the board of directors may adopt. He shall file all receipts, cashed checks and records, and write all checks issued by the company. The secretary, by authority of the president, shall sign all checks issued by the company, and with the president, sign all notes.

The secretary shall present to the board of directors at their monthly meeting a statement of the business of the company for the previous month. He shall also attend the annual meeting, present to the stockholders a complete record of the previous year's business, giving an itemized statement of the total expenditures and income for the year and a detailed report of the resources and liabilities of the company. For performing such duties, the secretary's compensation shall be fixed by the board of directors.

The secretary shall see that a full copy of the annual report is filed with the office of the Division of Markets, North Carolina Agricultural Experiment Station, West Raleigh.

Sec. 6. It shall be the duty of the treasurer to take care of the funds of the company. He shall make a monthly report to the board of directors, and an annual report to the stockholders of the company. The treasurer shall give bonds in the sum of.....dollars, same to be approved by the board of directors.

## ARTICLE IV.

### Capital Stock.

Section 1. The capital stock of this association shall be..... thousand dollars which shall be divided into.....hundred shares of.....dollars each, which shall be paid in at such times, and in such amounts as the board of directors may determine and may be paid either in cash, property, labor or securities, as the board of directors may determine.

Sec. 2. The stockholders shall meet on .....of each year and at such other times as is provided in Article III, section 3.

Sec. 3. Thirty per cent of the stockholders in number shall constitute a quorum for the transaction of business at any regular or special meeting of the stockholders.

## ARTICLE V.

### Apportionment of Earnings.

Section 1. The directors, subject to revisions by the association at any general or special meeting, shall apportion the earnings by first paying dividends on the paid-up capital stock not exceeding six per cent per annum. Then they should set aside not less than ten per cent of the net profits for a reserve fund until an amount has accumulated in said reserve fund equal to thirty per cent of the paid-up capital stock. Then the remainder of said net profits should be distributed by uniform

dividend upon the amount of purchases made by shareholders and upon the wages and salaries of employees, and one-half of such uniform dividend should be paid non-shareholders on the amount of their purchases. (This half-rate dividend may be credited to the account of such non-shareholders on account of capital stock of the association.)

SEC. 2. In selling agencies such as fruit, truck, peanut and cotton growers associations, and in productive associations such as creameries, canneries, warehouses, factories, and the like, dividends should be prorated according to the raw material delivered instead of on goods purchased. In case the association is both a selling and a productive concern, the dividends may be on both raw material delivered and on goods purchased by patrons.

## ARTICLE VI.

### SALE OF PRODUCTS.

SECTION 1. This organization shall have the exclusive and unqualified power to market those products of its members which the association was formed to sell, provided: If a competitor raises the price of farm products above that which the association gives, any stockholder may have the right to sell his products through an outside agency providing he pays his proper proportion of the running expenses to the association. This sum should not exceed five per cent of the value of products so sold to a competing concern.

## ARTICLE VII.

### AMENDMENTS TO BY-LAWS.

SECTION 1. These by-laws may be altered or amended by a two-thirds vote of the members present at any regular annual meeting or any special meeting called for that purpose. In the latter case ten days' notice thereof shall have been given to all the members previous to the time of voting thereon.

SEC. 2. Whenever, in the opinion of the board of directors, a change in the rules and regulations is necessary, they shall have power to initiate such change and refer it to the shareholders for final action.

## ARTICLE VIII.

### ORDER OF BUSINESS.

1. Call to order.
2. Roll call of officers.
3. Reading minutes of last meeting.
4. Reports of officers.
5. Reports of committees.
6. Report of education committee.
7. Reports of managers.
8. Communications and bills.
9. Grievances and complaints.
10. Consideration of reports.
11. Election of officers.

12. Filling vacancies.
13. Appointing committees.
14. Unfinished business.
15. New business.
16. Good of the company.
17. Sign minutes.
18. Adjournment.

### The Co-operative Society and the Ordinary Business Corporation

One great difference between the organization of farmers and that of those in manufacturing, transporting, mercantile and banking enterprises should be emphasized. In the ordinary business corporation there has been no consistent effort to distribute the profits to as many as possible. Some business pools have been democratic. Membership has been open to all on equal terms. As many as possible have been induced to join. But usually the great movement for the organization of all business except that of agriculture has had for its motive the profits which the leaders hoped to obtain out of it. The great fortunes of today are not made by the rank and file within business corporations but by their directors. Such profits come as a result of promotion, reorganization, consolidation and sale of securities generally. The promoters of the United States Steel Corporation received $150,000,000 par value of stock, or one-seventh of the total capital stock, for their services. Upon this stock they were able to realize a net profit of $62,500,000. It is by such efficient methods as this that wealth has become centralized in a few of the financial centers of the United States.

In the organization of the farming business the appeal for leadership can not be made to the self interests of the few. The aim in a Coöperative Society is not to give any special profits to promoters. Ownership of shares in an agricultural corporation must be distributed among as large a number of growers as possible in order to present a united front in the market. Shares must be made transferable only at the option of the growers so as to prevent the shares of the organization from falling into the hands of buyers, who naturally would control the organization for their own interests. If the shares are distributed to and kept in the hands of the growers in the proportion of their acreage, then it may be possible to distribute the profits to all growers in proportion to their contribution of products. This method of division of profits is the main distinction between a Coöperative Society and the ordinary business corporation.

If the appeal for leadership cannot be made mainly on the basis of self interest then the appeal must be made for a democratic leadership. Large land-holders should take the responsibility of leadership both to better preserve their own interests and to fufill their obligations to the community. If they do not, it is only a question of time when they will see the profits which might go to farming made by agencies outside of the land-holding interests. The only safeguard for the land-holding interests is organization as in other lines of business. Only through organization can the economies of large scale business be obtained.

These economies are easier and better sale of standardized products, more ample and cheaper credit facilities, carload shipments and better freight rates, a wider, more even and less expensive distribution of farm products, and a saving of payment of profits to others for marketing services whenever the work can be just as effectively done by a growers' organization.

If a farmers' organization is not to be controlled in the interests of a few the rank and file of growers will have to be trained to take an intelligent part in the organized business of farming. In the ordinary business corporation the stockholders may give little or no thought to what their directors are doing. Shareholders only ask for a dividend. A growers' organization cannot succeed on this basis. An efficient management must have an intelligent and loyal membership if the farmers' organization is to hold its own in competition with the powerful middlemen's organizations. Members that seize a temporary gain by the sale of their products to a competitor may be the means of destroying their own organization and of turning the whole business over to a hostile combination of middlemen. It may be penny gain and pound lost. Investment in stock in proportion to the acreage or to the contribution of products of each member will prevent a farmer from abandoning his organization for the casual gain of temporarily high prices. The necessity for an intelligent membership in every growers organization is what makes the organization of agriculture a vaster undertaking than that of any other line of business.

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## List of Farmers' Organizations in North Carolina †

ASHE COUNTY:

Sulzberger Colony of Jewish Farmers, Ashley, N. C.

The Union Company, Hopkins, N. C. Capital stock paid in, $2,500. General merchandise.

Todd Mercantile Company, Todd, N. C. Capital stock paid in, $2,000. General merchandise.

*In print.

†The Division of Markets will welcome any information which will make this list more complete.

BERTIE COUNTY:

Kelford Farmers' Union Warehouse Company. Capital stock paid in, $1,500. General merchandise.

BUNCOMBE COUNTY:

Buncombe County Union Supply Company, Asheville, N. C. Capital stock paid in, about $1,000. Feed and groceries.

BURKE COUNTY:

About $1,750 invested in local enterprises.

CALDWELL COUNTY:

Farmers' Produce Company, Sawmills, N. C. Capital stock paid in, $1,900. General merchandise.

CATAWBA COUNTY:

Catawba Coöperative Creamery Company Co., Hickory, N. C.

Catawba Sweet Potato Growers' Association, Hickory, N. C.

Catawba Land and Loan Association, Hickory.

Maiden Farmers' Cotton Warehouse Company, Maiden, N. C. Capital stock paid in, $400.

Claremont Coöperative Company, Claremont, N. C.

CHATHAM COUNTY:

Union Supply Company, Bear Creek, N. C. Capital stock, $3,500.

Alliance Manufacturing Company, Bear Creek, N. C. Capital stock, $2,000.

Union Alliance Store, Siler City, N. C. Capital stock, $8,000.

The Alliance Store, Harper's Crossroads, N. C. Capital stock, $3,000.

CLEVELAND COUNTY:

Shelby Creamery, Shelby, N. C.

Farmers' Ginning and Warehouse Company, Grover, N. C. $1,700.

Kings Mountain Union Warehouse Company, Kings Mountain, N. C. Capital stock paid in, $1,100. Assets worth $2,000. Storage and warehouse business.

Mooresboro Creamery, Mooresboro, N. C.

CUMBERLAND COUNTY:

Sherwood Coöperative Company, Sherwood, N. C.

DAVIDSON COUNTY:

Farmers' Coöperative Exchange, Lexington, N. C. Capital stock paid in, $750. Groceries and fertilizers.

DUPLIN COUNTY:

Union Supply Company, Warsaw, N. C. Capital stock paid in, $500, with capital stock increasing.

EDGECOMBE COUNTY:

Deep Creek Local Union No. 949, Speed, N. C. Capital stock, $2,500.

Mercer Coöperative Company, Mercer, N. C.

FRANKLIN COUNTY:

Farmers' Coöperative Company of Franklin County, Louisburg, N. C. Capital stock paid in, $6,690. Value of assets, $10,000. General storage and distributing business.

FORSYTH COUNTY:

Farmers' Union Agency Company, Winston-Salem, N. C. $1,200.

GASTON COUNTY:

Gaston Farmers' Union Warehouse Company, Gastonia, N. C. Capital stock, $7,000. Value, $10,000. Fertilizer and cotton.

Stanley Coöperative Creamery, Stanley, N. C.

GRANVILLE COUNTY:

Hebrew Farmers' Association, Wilton, N. C.

GUILFORD COUNTY:

Guilford Coöperative Supply Company, Greensboro, N. C. $1,000.

Carolina Warehouse Co., Greensboro, N. C.

HALIFAX COUNTY:
Farmers' Storage Warehouse Company, Scotland Neck, N. C. $2,895.

HAYWOOD COUNTY:
Canton Coöperative Company, Canton, N. C.

HENDERSON COUNTY:
Northwestern Jewish Farmers' Association, Bowman, N. C.
Farmers' Union Exchange, Hendersonville, N. C. Capital stock subscribed, $10,000.

HERTFORD COUNTY:
Hertford County Farmers' Union Warehouse Company, Ahoskie, N. C. Capital stock, $3,500.

IREDELL COUNTY:
Iredell Farmers' Union Warehouse Company. Warehouses at Statesville and Mooresville. Capital stock, $7,500. Value of assets, $10,000.

JOHNSTON COUNTY:
Most of the stock subscribed for a $6,000 warehouse at Selma. Lot donated by the town, valued at $2,000.

JONES COUNTY:
Farmers' Warehouse Company, Pollocksville, N. C. Capital stock, $1,600. Value of assets, $3,000. Cotton.

LENOIR COUNTY:
Farmers' Union Warehouse Company, Kinston, N. C. Capital stock paid in, $2,500. Value of assets, $4,500.

LINCOLN COUNTY:
Lincoln Coöperative Company, Lincoln, N. C.
Lincoln Farmers' Union Warehouse Company, Lincolnton, N. C. Capital stock paid in, about $2,000. Cotton, fertilizers and general storage. Value of assets, $4,000.

MECKLENBURG COUNTY:
N. C. Farmers' Union Warehouse Company, Charlotte, N. C.

MONTGOMERY COUNTY:
Coöperative Store, Mount Gilead, N. C. Capital stock paid in, $800.

MOORE COUNTY:
Farmers' Union Supply Company, Cameron, N. C.
Grassy Creek Supply Company, Spiers, N. C.
Sand Hills Farmers' Association, Pinehurst, N. C.

NASH COUNTY:
Nash County Storage and Warehouse Company, Nashville, N. C. Capital stock paid in, $3,000. Value of assets, $4,000.

NEW HANOVER COUNTY:
East Carolina Fruit Growers' and Truckers' Association, E. H. Bauman, Secretary, Wilmington, N. C.

ORANGE COUNTY:
Oaks Coöperative Company, Oaks, N. C.
Warehouse, Hillsboro, N. C.

PAMLICO COUNTY:
Pamlico County Warehouse Company, Oriental, N. C. Capital stock paid in, $3,000.
Grantsboro Store Company, Grantsboro, N. C. Capital stock paid in, $1,500. General merchandise and country produce.

PITT COUNTY:
$2,350 subscribed for a storage and distributing warehouse company for handling cotton, peanuts, and other farm products.

ROCKINGHAM COUNTY:
Leaksville Farmers' Warehouse Company, Leaksville, N. C. $1,250.
Reidsville Coöperative Tobacco Company, Reidsville, N. C. Capital stock, $10,000.

Rockingham County Union Warehouse Company. Capital stock paid in, $1,500.

Stoneville Farmers' Union Exchange Company, Stoneville, N. C. Capital stock, $4,000.

RUTHERFORD COUNTY:

About $1,000 subscribed for warehouse company.

STANLY COUNTY:

Stanly Union Warehouse Company, Albemarle, N. C. Capital stock paid in, about $1,500. Value of assets, $3,000. Fertilizers, farm implements, groceries, etc.

STOKES COUNTY:

Stokes County Union Warehouse Company, Walnut Cove, N. C. Capital stock paid in, $11,000.

Farmers' Union Bank and Trust Company, Walnut Cove, N. C. Capital stock, $25,000.

Stokes County Union Milling Company, Francisco, N. C. Capital stock, $12,000.

Stokes County Union Supply Company, Walnut Cove, N. C. Capital stock, $6.000.

Peters Creek Union Mill Company, Smith, N. C. Capital stock paid in, $8,000.

Farmers' Supply Company, Kings, N. C. Mercantile business.

SURRY COUNTY:

Surry County Dry Prize Company, Mount Airy, N. C. Capital stock paid in, $5,750. Value of lot and buildings, $20,000. Sale of leaf tobacco.

Surry-Wilkes-Yadkin Supply Company, Elkin, N. C. Capital stock, $4,000.

UNION COUNTY:

Coöperative Mercantile Company, Monroe, N. C. Capital stock paid in, $2,500. Groceries and fertilizers.

New Salem Coöperative Mercantile Company, Marshville, N. C. $2,050.

Union Coöperative Mercantile Company, Marshville, N. C. Capital stock, $800. Cash fund in bank used for trading fund.

VANCE COUNTY:

Vance Coöperative Tobacco Company, Manson, N. C. Storage and sale of tobacco and cotton. Capital stock, $3,500. Value of assets, $5,000.

WAKE COUNTY:

Farmers Warehouse Company, Fuquay Springs, N. C. $1,750.

WARREN COUNTY:

Macon Union Warehouse Company, Macon, N. C. Capital stock paid in, $235.

Warren Farmers' Warehouse Company, Warrenton, N. C. $5,600.

Also cotton gins at Oakville and Afton.

WATAUGA COUNTY:

Sands Mercantile Company, Sands, N. C. Capital stock, $1,500.

WILKES COUNTY:

Wilkes County Supply Company, North Wilkesboro, N. C. Capital stock, $1,500. General merchandise.

United Fruit Growers of Western North Carolina, Incorporated, North Wilkesboro, N. C.

WILSON COUNTY:

Farmers' Mercantile Agency, Lucama, N. C. Capital stock, $1,000. Cash grocery business. Value of assets, $1,500.

BULLETIN 226 MARCH 1914

NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

CONDUCTED JOINTLY BY THE

STATE DEPARTMENT OF AGRICULTURE

AND THE

COLLEGE OF AGRICULTURE AND MECHANIC ARTS

RALEIGH AND WEST RALEIGH

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# REPORT OF VARIETY TESTS OF COTTON FOR 1913, AND A SUMMARY OF RESULTS FOR THE PAST ELEVEN YEARS

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Bulletins of the Station Will be Sent Free to Citizens of the State on Request

# THE NORTH CAROLINA
# AGRICULTURAL EXPERIMENT STATION

CONDUCTED JOINTLY BY THE

## STATE DEPARTMENT OF AGRICULTURE

AND THE

## N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS

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[1]In cooperation with the U. S. Department of Agriculture, Bureau of Plant Industry.
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[4]In cooperation with the U. S. Department of Agriculture, Office of Experiment Stations.

# REPORT ON VARIETY TESTS OF COTTON FOR 1913

By R. Y. Winters, Agronomist in Plant Breeding.

In the spring of 1913 sixty-nine varieties of cotton were secured for the variety tests. These varieties include most of the short and long staple varieties grown in this and adjoining States. All of the varieties were tested on the Experiment Station farm at West Raleigh, but on account of lack of space only a portion of them could be planted at the Edgecombe and Iredell Test Farms.

## Plan of Testing.

The cotton varieties were divided into four groups as follows: Long staple, large boll, medium boll, and small boll varieties. According to this grouping, plants of similar size and growth habit are grown together. Varieties which are known to have originated from the same variety are grown side by side for comparison. Each variety is tested in duplicate rows which together make one-twentieth of an acre. Following each ten rows of varieties, one row of Culpepper's Improved is planted as a standard for comparison. Even though a very uniform piece of ground is selected for the test, an area sufficient to accommodate sixty or more varieties will naturally have good and poor areas. By planting a standard variety at regular intervals these spots are located, and corrections may be made for them. Culpepper's Improved has been grown on the Station farm for several years and at present furnishes the best standard for comparing different portions of the field. The rows are made 3½ feet apart and the seed are planted thick with an ordinary cotton planter. Soon after the first true leaf has expanded one and a half to two inches the plants are thinned to hills of one plant, fifteen inches apart in the row. The cotton varieties are given the same amount of fertilizer and cultivation as the general crop. When the plants are mature, note is made of the percentage of stand, unproductive plants, amount of disease, and uniformity of plants. Each row is picked separately and weighed. Just before each picking, 100 bolls are taken from each variety to be used in determining the size of boll, percentage of lint, length and strength of fiber. The bolls are taken from separate plants in order to secure the most representative sample.

## Experiment Station Farm.

At the Station farm the varieties were planted on May 21, in a fairly level field of Cecil Sandy Loam soil. With the exception of two varieties, a good stand was secured from the first planting. Dozier's Improved and Dillon gave a poor germination and a number of their seedlings died soon after germination.

The following tables give a list of the varieties, arranged according to the total value of their products. Although the short and long staple

varieties were grown under similar conditions they have been grouped separately for comparison.

Varieties of Short Staple Cotton Grown in 1913, Ranked According to Value of Seed and Lint Per Acre.

EXPERIMENT STATION FARM.

| Variety and Source of Seed | Yield of Seed Cotton, Lbs. Per Acre | Yield of Lint, Lbs. Per Acre | Yield of Seed, Lbs. Per Acre | Percent, of Lint |
|---|---|---|---|---|
| Cook's Improved Big Boll, R. B. Jones, Ellaville, Ga. | 1,012.0 | 430.5 | 581.5 | 42.12 |
| Sugar Loaf, Sugar Loaf Seed Farm, Youngsville, N. C. | 979.0 | 374.0 | 605.0 | 38.20 |
| Triumph, Excelsior Seed Farm, Cheraw, S. C. | 1,001.0 | 364.3 | 636.7 | 36.39 |
| Trice, J. F. Bridger, Bells, Tenn. | 1,045.0 | 361.0 | 684.0 | 34.64 |
| Culpepper's Re-improved Big Boll, J. E. Culpepper, Luthersville, Ga. | 979.0 | 364.9 | 614.1 | 37.27 |
| Wanamaker Pedigree Cleveland Big Boll, Modern Seed Farm, St. Matthews, S. C. | 896.5 | 368.4 | 528.1 | 41.09 |
| Mortgage Lifter, H. G. Hastings Co., Atlanta, Ga. | 968.0 | 356.3 | 611.7 | 36.81 |
| Bank Account, H. G. Hastings Co., Atlanta, Ga. | 968.0 | 354.2 | 613.8 | 36.54 |
| Crawford's Improved Big Boll, S. A. Crawford, Williston, Tenn. | 924.0 | 357.8 | 566.2 | 38.72 |
| Cleveland's Big Boll, J. R. Cleveland, Decatur, Ga. | 913.0 | 357.0 | 556.0 | 39.10 |
| Cleveland's Big Boll, Excelsior Seed Farm, Cheraw, S. C. | 924.0 | 355.2 | 568.8 | 38.44 |
| Sunbeam, J. T. Dennis, Elberton, Ga. | 913.0 | 350.2 | 562.8 | 38.36 |
| King's Improved, Iredell Test Farm, Statesville, N. C. | 935.0 | 347.5 | 587.5 | 37.17 |
| Hawkin's Extra Prolific, B. W. Hawkins, Eatonton, Ga. | 900.0 | 340.3 | 559.7 | 37.81 |
| Culpepper's Improved, Station Farm, West Raleigh, N. C. | 902.0 | 337.0 | 565.0 | 37.36 |
| Summerour's Half and Half, H. H. Summerour, Duluth, Ga. | 742.5 | 355.1 | 387.4 | 47.83 |
| Brown, No. 1, M. L. Brown, Decatur, Ga. | 874.5 | 338.4 | 536.1 | 38.70 |
| Hope's Mexican Big Boll, J. D. Hope, Sharon, S. C. | 896.5 | 331.5 | 565.0 | 36.98 |
| Uncle Sam, J. A. Wade, Alexander City, Ala. | 869.0 | 331.1 | 537.9 | 38.10 |
| Perry's Improved, Miley Perry, Raleigh, N. C. | 863.5 | 325.0 | 538.5 | 37.64 |
| Rosser No. 1, H. G. Hastings Seed Co., Atlanta, Ga. | 891.0 | 329.0 | 562.0 | 36.92 |
| Toole's Prolific, W. W. Toole, Augusta, Ga. | 825.0 | 334.0 | 491.0 | 40.49 |
| Truitt's Ninety Day, J. G. Truitt, LaGrange, Ga. | 880.0 | 318.5 | 561.5 | 36.19 |
| Double Header, R. H. Smith, Monticello, Ga. | 902.0 | 314.0 | 588.0 | 34.81 |

EXPERIMENT STATION FARM—CONTINUED.

| Variety and Source of Seed | Yield of Seed Cotton, Lbs. Per Acre | Yield of Lint, Lbs. Per Acre | Yield of Seed, Lbs. Per Acre | Percent. of Lint |
|---|---|---|---|---|
| Peterkin, Jasper Fletcher, McColl, S. C. | 792.0 | 321.9 | 470.1 | 40.64 |
| Langford's Big Boll, W. S. Sanders, Danielsville, Ga. | 808.5 | 317.3 | 491.2 | 39.24 |
| Thigpen's Prolific, J. T. Thigpen, Conetoe, N. C. | 825.0 | 307.6 | 517.4 | 37.29 |
| Half and Half, Oscar Haaga, Memphis, Tenn. | 781.0 | 310.0 | 470.8 | 39.84 |
| Dongola, Excelsior Seed Farm, Cheraw, S. C. | 808.5 | 303.6 | 504.9 | 37.55 |
| Spring Grove Cotton, S. A. Brown, Cross Hill, S. C. | 803.0 | 301.8 | 501.2 | 37.58 |
| Truitt's Improved, Geo. W. Truitt, LaGrange, Ga. | 830.5 | 298.3 | 532.2 | 35.92 |
| Hite's Early Prolific, W. T. Hite, Augusta, Ga. | 764.5 | 303.0 | 461.5 | 39.64 |
| Broadwell's Double Jointed, John B. Broadwell, Alpharetta, Ga. | 775.5 | 295.4 | 480.1 | 38.09 |
| Mitchell's Early Prolific Yield, Sugar Loaf Cotton Farm, Youngsville, N. C. | 737.0 | 299.1 | 437.1 | 40.59 |
| Willet Red Leaf, N. L. Willet Seed Co., Augusta, Ga. | 770.0 | 292.0 | 478.0 | 37.92 |
| Winesap, R. H. Gower, Clayton, N. C. | 880.0 | 278.2 | 601.8 | 31.61 |
| Russell's Big Boll, Edgecombe Test Farm, Rocky Mount, N. C. | 781.0 | 286.5 | 494.5 | 36.68 |
| Texas Bur, C. E. Smith, Locust Grove, Ga. | 786.5 | 284.5 | 502.0 | 36.17 |
| Prize, W. B. F. Lewis, Lewiston, La. | 742.5 | 284.7 | 457.8 | 38.34 |
| Shine's Early Prolific, J. A. Shine, Faison, N. C. | 770.0 | 280.3 | 489.7 | 36.40 |
| Christopher's Improved, R. L. Christopher, LaGrange, Ga. | 715.0 | 266.4 | 448.6 | 37.26 |
| Texas Black Wood, H. M. N. Watson, Red Springs, N. C. | 643.5 | 270.0 | 373.5 | 41.97 |
| Money Maker, Alexander Seed Co., Augusta, Ga. | 638.0 | 254.6 | 383.4 | 39.90 |
| Allen's Multiplier, N. J. Allen, Clayton, N. C. | 682.0 | 247.4 | 434.6 | 36.42 |
| Bradbury's Improved, J. E. Bradbury, Jr., & Son, Athens, Ga. | 632.5 | 247.4 | 385.1 | 39.11 |
| Braddy, L. C. Braddy, Dillon, S. C. | 632.5 | 245.0 | 387.5 | 38.74 |
| Wannamaker's Pedigree Toole, Modern Seed Farm, St. Matthews, S. C. | 577.5 | 237.9 | 339.6 | 41.20 |
| Triumph Improved, R. T. Malone, Capleville, Tenn. | 605.0 | 231.7 | 373.3 | 38.29 |
| Improved Peeler, Napier Bros. Seed Farm, Blenheim, S. C. | 715.0 | 225.5 | 489.5 | 31.54 |
| Dixie, U. S. Department of Agriculture | 660.0 | 226.8 | 433.2 | 34.37 |
| Covington-Toole's Wilt Resistant, W. F. Covington, Headland, Ala. | 550.0 | 226.3 | 323.7 | 41.14 |
| Moss' Improved, A. B. Moss, Norway, S. C. | 522.5 | 221.8 | 300.7 | 42.45 |

EXPERIMENT STATION FARM—Continued.

| Variety and Source of Seed | Yield of Seed Cotton, Lbs. Per Acre | Yield of Lint, Lbs. Per Acre | Yield of Seed, Lbs. Per Acre | Percent, of Lint |
|---|---|---|---|---|
| Dozier's Improved, M. D. Dozier, Camden, N. C. | 473.0 | 175.2 | 297.8 | 37.04 |
| Dillon, U. S. Dept. of Agriculture | 434.5 | 174.5 | 260.0 | 40.15 |

## Varieties of Long Staple Cotton Grown in 1913, Ranked According to Value of Seed and Lint Per Acre.

EXPERIMENT STATION FARM.

| Variety and Source of Seed | Yield of Seed Cotton, Lbs. Per Acre | Yield of Lint, Lbs. Per Acre | Yield of Seed, Lbs. Per Acre | Percent. of Lint | Length of Staple, Inches |
|---|---|---|---|---|---|
| Columbia, Oscar Haaga, Memphis, Tenn. | 924.0 | 314.7 | 609.3 | 34.06 | 1.30 |
| Webber, Oscar Haaga, Memphis, Tenn. | 825.0 | 284.9 | 540.1 | 34.53 | 1.38 |
| Haaga's Foster, Oscar Haaga, Memphis, Tenn. | 803.0 | 296.0 | 507.0 | 36.87 | 1.50 |
| Hartsville No. 7, D. R. Coker, Hartsville, S. C. | 803.0 | 286.6 | 516.4 | 35.45 | 1.38 |
| Keenan, R. C. Keenan, Columbia, S. C. | 814.0 | 277.8 | 536.2 | 34.13 | 1.38 |
| Keenan, W. B. Lorance, Columbia, S. C. | 803.0 | 269.2 | 533.8 | 33.52 | 1.38 |
| Lewis' Long Staple, E. P. Lewis, Gastonia, N. C. | 786.5 | 260.7 | 525.8 | 33.15 | 1.50 |
| Sunflower, Mark Schaeffer, Yazoo City, Miss. | 803.0 | 257.9 | 545.1 | 32.12 | 1.54 |
| Acme, A. M. Huggins, Lamar, S. C. | 764.5 | 268.1 | 496.4 | 35.07 | 1.50 |
| Keenan, (Goodson), D. R. Coker, Hartsville, S. C. | 753.5 | 266.0 | 487.5 | 35.30 | 1.38 |
| Webber, D. R. Coker, Hartsville, S. C. | 759.0 | 260.8 | 498.2 | 34.36 | 1.54 |
| Columbia, D. J. Griffith, Columbia, S. C. | 759.0 | 259.7 | 499.3 | 34.21 | 1.30 |
| Piedmont Long Staple, Hickory Seed Co., Hickory, N. C. | 755.5 | 252.5 | 523.0 | 32.54 | 1.34 |
| Allen's Early, J. B. Allen, Port Gibson, Miss. | 759.0 | 236.1 | 522.9 | 31.11 | 1.62 |
| Haaga No. 1, Oscar Haaga, Memphis, Tenn. | 478.5 | 178.9 | 299.6 | 37.39 | 1.18 |

In determining the rank of the above varieties no account has been taken of quality and length of staple for individual varieties. A uniform price has been set for all short staple varieties and another for all long staple varieties. For this reason it has been considered best to

re-arrange the long staple varieties on the basis of length and uniformity of staple in the following table:

VARIETIES OF LONG STAPLE COTTON GROWN IN 1913, RANKED ACCORDING TO LENGTH AND UNIFORMITY.

EXPERIMENT STATION FARM.

| Variety and Source of Seed | Yield of Seed Cotton, Lbs. Per Acre | Yield of Lint, Lbs. Per Acre | Yield of Seed, Lbs. Per Acre | Percent. of Lint | Length of Staple, Inches |
|---|---|---|---|---|---|
| Allen's Early | 759.0 | 178.9 | 299.6 | 31.11 | 1.62 |
| Lewis' Long Staple | 786.5 | 260.7 | 525.8 | 33.15 | 1.50 |
| Webber (Coker) | 759.0 | 260.8 | 498.2 | 34.36 | 1.54 |
| Sunflower | 803.0 | 257.9 | 545.1 | 32.12 | 1.54 |
| Acme | 764.5 | 268.1 | 496.4 | 35.07 | 1.50 |
| Haaga's Foster | 803.0 | 296.0 | 507.0 | 36.87 | 1.50 |
| Hartsville No. 7 | 803.0 | 286.6 | 516.4 | 35.45 | 1.38 |
| Webber (Haaga) | 825.0 | 284.9 | 540.1 | 34.53 | 1.38 |
| Keenan (Goodson) | 753.5 | 266.0 | 487.5 | 35.30 | 1.38 |
| Keenan (Keenan) | 814.0 | 277.8 | 536.2 | 34.13 | 1.38 |
| Keenan (Lorance) | 803.0 | 269.2 | 533.8 | 33.52 | 1.38 |
| Piedmont Long Staple | 775.5 | 252.5 | 523.0 | 32.54 | 1.34 |
| Columbia (Griffith) | 759.0 | 259.7 | 499.3 | 34.21 | 1.30 |
| Columbia (Haaga) | 924.0 | 314.7 | 609.3 | 34.06 | 1.30 |
| Haaga No. 1 | 478.5 | 178.9 | 299.6 | 37.39 | 1.18 |

## SUMMARY OF RESULTS.

At the Experiment Station farm the short staple varieties ranged in yield between 434.5 and 1,045 pounds of seed cotton per acre. The fifty-four short staple varieties produced an average yield of 799 pounds of seed cotton or 304 pounds of lint and 495 pounds of seed.

The fifteen long staple varieties ranged in yield between 479.5 and 927 pounds of seed cotton, giving an average yield of 774 pounds of seed cotton, or 264.5 pounds of lint and 509 pounds of seed.

As a result of tests during three consecutive years at the Experiment Station farm, the following varieties have proven most productive.

MOST PRODUCTIVE COTTON VARIETIES IN AN AVERAGE OF THREE CONSECUTIVE TESTS.

| *1908-1910.* | *1910-1912.* |
|---|---|
| Culpepper's Re-improved. | Cook's Improved. |
| Williams' Improved. | Hawkins' Extra Prolific. |
| Broadwell's Double Jointed. | Edgeworth. |
| Hawkins' Extra Prolific. | Cleveland Big Boll. |
| Toole's Prolific. | Triumph. |
| Columbia Long Staple. | Dillon Wilt Resistant. |

The varieties named above are arranged in order of productiveness.

## Edgecombe Farm.

It is the object of the Experiment Station to find out as far as possible the type of plant best suited to the different cotton-growing sections of the State. The fact that the cotton-growing sections of the State vary in soil and climatic conditions naturally indicates that they require different strains of cotton. For this reason it is impossible to determine the suitability of a variety to all portions of the State by growing it on the Experiment Station Farm. In order to determine the best cotton for a section, various kinds should be grown under conditions which represent it. It is true too, that the experience of one year is not sufficient to determine the best kind, for seasons vary from one year to the other. Previous studies made on the Station Farm show that varieties differ in their response to these changes in season. A variety which yields well one season may be a failure when grown another year. In order to have the studies apply to conditions not represented by the Experiment Station Farm, similar studies are made at the test farms located in Edgecombe and Iredell counties.

During the past season fifty-eight varieties of cotton were grown at the Edgecombe Farm. Of this number eleven were long staple upland varieties and forty-seven belonged to the short staple group. The varieties were planted on April 29, in a uniform field of Norfolk Sandy Loam Soil. All of the varieties gave a good germination and a good stand of cotton. The following tables contain a list of the varieties arranged according to the total value of their lint and seed. Along with each variety is given its yield of seed cotton, lint, seed and its percentage of lint.

### Varieties of Short Staple Cotton Grown in 1913, Ranked According to Value of Seed and Lint Per Acre.

EDGECOMBE FARM.

| Variety and Source of Seed | Yield of Seed Cotton, Lbs. Per Acre | Yield of Lint, Lbs. Per Acre | Yield of Seed, Lbs. Per Acre | Percent. of Lint |
|---|---|---|---|---|
| Prize, W. B. F. Lewis, Lewiston, La. | 1,200 | 439.7 | 760.3 | 36.64 |
| Covington-Toole's Wilt Resistant, W. F. Covington, Headland, Ala. | 1,000 | 404.1 | 595.9 | 40.41 |
| Crawford's Improved Big Boll, S. A. Crawford, Williston, Tenn. | 1,060 | 397.0 | 663.0 | 37.46 |
| Langford' Big Boll, W. S. Sanders, Danielsville, Ga. | 1,060 | 387.9 | 672.1 | 36.59 |
| Sugar Loaf, Sugar Loaf Seed Farm, Youngsville, N. C. | 1,040 | 387.0 | 653.0 | 37.22 |
| Perry's Improved, Miley Perry, Raleigh, N. C. | 1,040 | 383.0 | 657.0 | 36.83 |
| Toole's Prolific, W. W. Toole, Augusta, Ga. | 1,000 | 385.7 | 614.3 | 38.57 |
| Money Maker, Alexander Seed Co., Augusta, Ga. | 940 | 365.3 | 574.7 | 38.86 |
| Thigpen's Prolific, J. L. Thigpen, Conetoe, N. C. | 1,020 | 355.0 | 665.0 | 34.81 |

EDGECOMBE FARM—CONTINUED.

| Variety and Source of Seed | Yield of Seed Cotton, Lbs. Per Acre | Yield of Lint, Lbs. Per Acre | Yield of Seed, Lbs. Per Acre | Percent, of Lint |
|---|---|---|---|---|
| Shine's Early Prolific, J. A. Shine, Faison, N. C. | 1,020 | 355.0 | 665.0 | 34.81 |
| Dongola, Excelsior Seed Farm, Cheraw, S. C. | 960 | 354.8 | 605.2 | 36.96 |
| Cleveland's Big Boll, J. R. Cleveland, Decatur, Miss. | 960 | 353.8 | 606.2 | 36.85 |
| Russell's Big Boll, Edgecombe Test Farm | 980 | 346.2 | 633.8 | 35.33 |
| Wannamaker's Pedigree Cleveland Big Boll, Model Seed Farm, St Matthews, S. C. | 900 | 357.0 | 542.8 | 39.69 |
| Half and Half, Oscar Haaga, Memphis, Tenn. | 900 | 350.8 | 549.2 | 38.98 |
| Braddy, L. C. Braddy, Dillon, S. C. | 860 | 343.7 | 516.3 | 39.96 |
| Moss' Improved, A. B. Moss, Norway, S. C. | 840 | 347.4 | 492.6 | 41.36 |
| Winesap, R. H. Gower, Clayton, N. C. | 1,000 | 325.8 | 674.2 | 32.58 |
| Cleveland's Big Boll, Excelsior Seed Farm, Cheraw, S. C. | 900 | 328.2 | 571.8 | 36.47 |
| Culpepper's Re-improved Big Boll, J. E. Culpepper, Luthersville, Ga. | 920 | 325.4 | 594.6 | 35.37 |
| Uncle Sam, J. A. Wade, Alexander City, Ala. | 900 | 326.0 | 574.0 | 36.22 |
| Allen's Multiplier, N. J. Allen, Clayton, N. C. | 900 | 322.8 | 577.2 | 35.87 |
| Brown No. 1, M. L. Brown, Decatur, Ga. | 880 | 322.6 | 557.4 | 36.66 |
| Wannamaker's Pedigree Tool, Model Seed Farm, St. Matthews, S. C. | 820 | 326.5 | 493.5 | 39.82 |
| Texas Bur, C. E. Smith, Locust Grove, Ga. | 880 | 310.1 | 569.9 | 35.24 |
| Bank Account, H. G. Hastings, Atlanta, Ga. | 860 | 311.7 | 548.3 | 36.24 |
| Truitt's Ninety Day, J. G. Truitt, LaGrange, Ga. | 880 | 307.6 | 572.4 | 34.96 |
| Mitchell's Early Prolific Yield, Sugar Loaf Cotton Farm, Youngsville, N. C. | 780 | 305.8 | 474.2 | 39.20 |
| Double Header, R. H. Smith, Monticello, Ga. | 860 | 292.6 | 567.4 | 34.02 |
| Texas Black Wood, H. M. N. Watson, Red Springs, N. C. | 720 | 294.7 | 425.3 | 40.93 |
| Spring Grove Cotton, S. A. Brown, Cross Hill, S. C. | 780 | 283.0 | 497.0 | 36.29 |
| Truitt's Improved, Geo. W. Truitt, LaGrange, Ga. | 800 | 279.8 | 520.2 | 34.98 |
| Broadwell's Double Jointed, John B. Broadwell, Alpharetta, Ga. | 800 | 275.5 | 524.5 | 34.44 |
| Mortgage Lifter, H. G. Hastings, Atlanta, Ga. | 740 | 279.9 | 460.1 | 37.83 |
| Triumph Improved, R. T. Malone, Capleville, Tenn. | 740 | 279.4 | 460.6 | 37.76 |
| Hite's Early Prolific, W. T. Hite, Augusta, Ga. | 720 | 277.3 | 442.7 | 38.51 |
| Rosser No. 1, H. G. Hastings Co., Atlanta, Ga. | 780 | 267.9 | 512.1 | 34.34 |

EDGECOMBE FARM—Continued.

| Variety and Source of Seed | Yield of Seed Cotton, Lbs. Per Acre | Yield of Lint, Lbs. Per Acre | Yield of Seed, Lbs. Per Acre | Percent. of Lint |
|---|---|---|---|---|
| Hawkins Extra Prolific, B. W. Hawkins, Eatonton, Ga. | 740 | 255.2 | 484.8 | 34.48 |
| Peterkin, Jasper Fletcher, McColl, S. C. | 660 | 263.3 | 396.7 | 39.90 |
| King's Improved, Iredell Test Farm | 700 | 258.3 | 441.7 | 36.90 |
| Triumph, Excelsior Seed Farm, Cheraw, S. C. | 700 | 255.2 | 444.8 | 36.46 |
| Improved Peeler, Napier Bros. Seed Farm, Blenheim, S. C. | 780 | 236.7 | 543.3 | 30.35 |
| Bradbury's Improved, J. E. Bradbury, Athens, Ga. | 660 | 239.4 | 420.6 | 36.27 |
| Dozier's Improved, M. D. Dozier, Camden, N. C. | 660 | 228.1 | 431.9 | 34.56 |
| Summerour's Half and Half, H. H. Summerhour, Duluth, Ga. | 540 | 235.2 | 304.8 | 43.56 |
| Willet Red Leaf, N. L. Willet Seed Co., Augusta, Ga. | 500 | 190.5 | 309.5 | 38.10 |
| Christopher's Improved, R. L. Christopher, LaGrange, Ga. | 540 | 183.8 | 356.2 | 34.04 |

## Varieties of Long Staple Cotton Grown in 1913, Ranked According to Value of Seed and Lint Per Acre.

EDGECOMBE FARM.

| Variety and Source of Seed | Yield of Seed Cotton, Lbs. Per Acre | Yield of Lint, Lbs. Per Acre | Yield of Seed, Lbs. Per Acre | Percent. of Lint | Length of Staple, Inches |
|---|---|---|---|---|---|
| Columbia, Oscar Haaga, Memphis, Tenn. | 980 | 319.6 | 660.4 | 32.61 | 1.20 |
| Keenan (Goodson), D. R. Coker, Hartsville, S. C. | 780 | 267.6 | 512.4 | 34.31 | 1.36 |
| Keenan, W. B. Lorance, Columbia, S. C. | 780 | 259.3 | 520.7 | 33.24 | 1.44 |
| Columbia, B. J. Griffith, Columbia, S. C. | 780 | 256.3 | 523.7 | 32.86 | 1.44 |
| Keenan, R. C. Keenan, Columbia, S. C. | 760 | 252.8 | 507.2 | 33.26 | 1.44 |
| Piedmont Long Staple, Hickory Seed Co., Hickory, N. C. | 660 | 213.2 | 446.8 | 32.31 | 1.24 |
| Acme, A. M. Huggins, Lamar, S. C. | 640 | 212.2 | 427.8 | 33.16 | 1.44 |
| Allen's Early, J. B. Allen, Port Gibson, Miss. | 680 | 206.3 | 473.7 | 30.34 | 1.56 |
| Hartsville No. 7, D. R. Coker, Hartsville, S. C. | 580 | 190.9 | 389.1 | 32.92 | 1.40 |
| Webber, D. R. Coker, Hartsville, S. C. | 520 | 168.3 | 351.7 | 32.37 | 1.44 |
| Lewis' Long Staple, E. P. Lewis, Gastonia, N. C. | 540 | 165.1 | 374.9 | 30.58 | 1.52 |

### SUMMARY OF RESULTS.

The forty-seven varieties of short staple cotton grown at the Edgecombe Farm ranged in yield between 1,200 and 540 pounds of seed cotton per acre. The varieties on this farm produced an average yield of 849 pounds of seed cotton, or 313 pounds of lint and 536 pounds of seed per acre. The long staple varieties ranged in yield between 980 and 540 pounds of seed cotton per acre and produced an average yield of 700 pounds of seed cotton or 228 pounds of lint and 472 pounds of seed per acre.

Judging from the productiveness of varieties studied at the Edgecombe Farm during the past ten years the following are best suited to those conditions:

MOST PRODUCTIVE VARIETIES AT THE EDGECOMBE FARM, 1902-1912.

| | |
|---|---|
| Shine's Early Prolific. | Sugar Loaf. |
| Brown No. 1. | Cook's Improved. |
| Russell's Big Boll. | King's Improved. |

None of the above varieties have been grown less than four of the ten years, and all of them have been a part of the same test during four years.

### IREDELL FARM.

During the past season forty-seven varieties of cotton were grown on the Iredell Farm. Of this number thirty-nine are short staple and eight are long staple upland varieties. The varieties were planted in a uniform field of Cecil Clay Soil. Immediately following the time of planting there was a cold, wet period which caused a very irregular germination. Seed from most of the varieties were germinating five weeks after the time of planting. By the middle of June all of the varieties except three had a fairly uniform stand of plants. Triumph from Excelsior Seed Farm, Dozier's Improved and Shine's Early Prolific fell below the average in germination, and a number of their seedlings died after germination.

The following tables give the yield of seed cotton, lint and seed per acre and the percentage of lint for each variety grown at the Iredell Farm. The varieties are arranged according to the combined value of their lint and seed.

## Varieties of Short Staple Cotton Grown in 1913, Ranked According to Value of Seed and Lint Per Acre.

IREDELL FARM.

| Variety and Source of Seed | Yield of Seed Cotton, Lbs. Per Acre | Yield of Lint, Lbs. Per Acre | Yield of Seed, Lbs. Per Acre | Percent, of Lint |
|---|---|---|---|---|
| King's Improved, Iredell Test Farm | 1,560 | 595.8 | 964.2 | 38.19 |
| Broadwell's Double Jointed, John B. Broadwell, Alpharetta, Ga. | 1,460 | 577.0 | 883.0 | 39.52 |
| Brown No. 1, M. L. Brown, Decatur, Ga. | 1,400 | 558.3 | 841.7 | 39.88 |
| Perry's Improved, Miley Perry, Raleigh, N. C. | 1,320 | 562.5 | 757.5 | 42.61 |
| Sugar Loaf, Sugar Loaf Seed Farm, Youngsville, N. C. | 1,360 | 550.8 | 809.2 | 40.50 |
| Langford's Big Boll, W. S. Sanders, Danielsville, Ga. | 1,310 | 546.7 | 763.3 | 39.05 |
| Cleveland's Big Boll, J. R. Cleveland, Decatur, Miss. | 1,290 | 501.3 | 788.7 | 38.86 |
| Bank Account, H. G. Hastings Seed Co., Atlanta, Ga. | 1,270 | 495.2 | 774.8 | 38.99 |
| Triumph Improved, R. T. Malone, Capleville, Tenn. | 1,170 | 460.0 | 710.0 | 39.32 |
| Russell's Big Boll, Edgecome Test Farm | 1,230 | 451.4 | 778.6 | 35.89 |
| Double Header, R. H. Smith, Monticello, Ga. | 1,250 | 443.0 | 807.0 | 35.44 |
| Culpepper's Re-improved, J. E. Culpepper, Luthersville, Ga. | 1,200 | 425.8 | 774.2 | 35.48 |
| Rosser No. 1, H. G. Hastings Seed Co., Atlanta, Ga. | 1,160 | 430.8 | 727.8 | 37.14 |
| Truitt's Ninety Day, J. G. Truitt, LaGrange, Ga. | 1,040 | 405.8 | 634.2 | 39.02 |
| Crawford's Improved Big Boll, S. A. Crawford, Williston, Tenn. | 1,090 | 397.8 | 692.2 | 36.50 |
| Uncle Sam, J. A. Wade, Alexander City, Ala. | 970 | 397.4 | 572.6 | 40.97 |
| Thigpen's Prolific, J. L. Thigpen, Conetoe, N. C. | 960 | 368.5 | 591.5 | 38.39 |
| Winesap, R. H. Gower, Clayton, N. C. | 1,000 | 365.6 | 634.4 | 36.56 |
| Moss' Improved, A. B. Moss, Norway, S. C. | 840 | 373.3 | 466.7 | 44.44 |
| Allen's Multiplier, N. J. Allen, Clayton, N. C. | 920 | 360.5 | 559.5 | 39.19 |
| Shine's Early Prolific, J. A. Shine, Faison, N. C. | 950 | 347.2 | 602.8 | 36.55 |
| Hawkins' Extra Prolific, B. W. Hawkins, Eatonton, Ga. | 900 | 340.3 | 559.7 | 37.81 |
| Hite's Early Prolific, W. T. Hite, Augusta, Ga. | 810 | 340.0 | 470.0 | 41.98 |
| Cleveland's Big Boll, Excelsior Seed Farm, Cheraw, S. C. | 790 | 314.7 | 475.3 | 39.84 |
| Mortgage Lifter, H. G. Hastings Seed Co., Atlanta, Ga. | 820 | 304.6 | 515.4 | 37.15 |
| Texas Bur, C. E. Smith, Locust Grove, Ga. | 790 | 299.2 | 490.8 | 37.87 |

IREDELL FARM—CONTINUED.

| Variety and Source of Seed | Yield of Seed Cotton, Lbs. Per Acre | Yield of Lint, Lbs. Per Acre | Yield of Seed, Lbs. Per Acre | Percent. of Lint |
|---|---|---|---|---|
| Bradbury's Improved, J. E. Bradbury, Jr., & Son, Athens, Ga. | 760 | 299.2 | 460.8 | 39.38 |
| Truitt's Improved, Geo. W. Truitt, LaGrange, Ga. | 760 | 283.4 | 476.6 | 37.29 |
| Mitchell's Early Prolific Yield, Sugar Loaf Cotton Farm, Youngsville, N. C. | 710 | 279.0 | 431.0 | 39.29 |
| Braddy, L. C. Braddy, Dillon, S. C. | 690 | 277.5 | 412.5 | 40.22 |
| Willet Red Leaf, N. L. Willet Seed Co., Augusta, Ga. | 660 | 267.6 | 392.4 | 40.55 |
| Texas Black Wood, H. M. N. Watson, Red Springs, N. C. | 630 | 269.8 | 360.2 | 42.82 |
| Christopher's Improved, R. L. Christophers, LaGrange, Ga. | 690 | 259.2 | 430.8 | 37.57 |
| Peterkin, Jasper Fletcher, McColl, S. C. | 610 | 252.5 | 357.5 | 41.39 |
| Improved Peeler, Napier, Bros. Seed Farm, Blenheim, S. C. | 690 | 218.8 | 471.2 | 31.71 |
| Triumph, Excelsior Seed Farm, Cheraw, S. C. | 600 | 231.2 | 368.8 | 38.53 |
| Dongola, Excelsior Seed Farm, Cheraw, S. C. | 510 | 195.9 | 314.1 | 38.42 |
| Dozier's Improved, M. D. Dozier, Camden, N. C. | 360 | 138.7 | 221.3 | 35.76 |
| Summerour's Half and Half, H. H. Summerour, Duluth, Ga. | 300 | 131.9 | 168.1 | 43.98 |

## VARIETIES OF LONG STAPLE COTTON GROWN IN 1913, RANKED ACCORDING TO VALUE OF SEED AND LINT PER ACRE.

IREDELL FARM.

| Variety and Source of Seed | Yield of Seed Cotton, Lbs. Per Acre | Yield of Lint, Lbs. Per Acre | Yield of Seed, Lbs. Per Acre | Percent. of Lint | Length of Staple, Inches |
|---|---|---|---|---|---|
| Columbia, D. J. Griffith, Columbia, S. C. | 870 | 311.0 | 559.0 | 35.75 | 1.28 |
| Allen's Early J. B. Allen, Port Gibson, Miss. | 960 | 298.8 | 661.2 | 31.13 | 1.52 |
| Hartsville No. 7 D. R. Coker, Hartsville, S. C. | 840 | 306.3 | 533.7 | 36.47 | 1.32 |
| Webber, D. R. Coker, Hartsville, S. C. | 840 | 280.6 | 559.4 | 33.41 | 1.36 |
| Piedmont Long Staple, Hickory Seed Co., Hickory, N. C. | 790 | 281.8 | 508.2 | 34.41 | *1.32–1.52 |
| Lewis' Long Staple, E. P. Lewis, Gastonia, N. C. | 850 | 271.9 | 578.1 | 31.99 | 1.46 |
| Acme, A. M. Huggins, Lamar, S. C. | 650 | 234.6 | 415.4 | 36.10 | 1.40 |
| Keenan, R. C. Keenan, Columbia, S. C. | 350 | 120.4 | 229.6 | 34.42 | 1.32 |

*Mixed.

### Summary of Results.

Unfavorable weather conditions at the Iredell Farm, just after the time of planting, were responsible for a very irregular germination of the cotton varieties. In spite of the irregular germination, however, a fairly uniform stand was secured.

Ranging in yield from 300 to 1,560 pounds of seed cotton per acre, the short staple varieties gave an average yield of 944 pounds of seed cotton or 367 pounds of lint and 577 pounds of seed per acre. The above is a much broader range in yield than was secured at either of the other farms. Both the maximum and minimum yields exceeded the range of the other two. The long staple varieties ranged in yield between 350 and 960 pounds of seed cotton per acre and produced an average yield of 768 pounds of seed cotton or 263 pounds of lint and 505 pounds of seed.

During the past nine years eighty-two varieties of cotton have been grown and studied at the Iredell Farm. Some of these have been grown only one year, and very little is known of such varieties. Considering only those varieties which have been grown three or more consecutive years, the following have been chosen as the best adapted to Iredell conditions:

Most Productive Varieties for the Iredell Farm, 1903-1912.

| | |
|---|---|
| King's Improved. | Russell's Big Boll. |
| Shine's Early Prolific. | Brown No. 1. |
| Cook's Improved. | Sugar Loaf. |

The varieties are arranged in order of their productiveness.

### Practical Information Secured From the Variety Studies.

During the past eleven years the Experiment Station has had under observation about one hundred different varieties of cotton. All of these have been grown on the Experiment Station Farm and most of them have been grown on the Test farms in Edgecombe and Iredell counties. Besides these, studies of a few varieties have been made in Currituck, Union, Pitt, Mecklenburg, Lincoln, and Nash counties. As a result of these studies the Experiment Station has collected data which in a general way indicates the kind of cotton which is best adapted to different sections of the State.

### Poor Varieties.

The fact that one variety is a poor yielder at one or all of the farms does not necessarily mean that it would have yielded as poorly under different conditions. Some varieties which ranked high at the Iredell Farm have been poor yielders at the Edgecombe Farm in the same year's test. The varieties may have been selected for conditions entirely different from those at the Iredell Farm. It suggests the importance of selecting cotton seed for local conditions instead of securing seed from other localities.

The study of cotton varieties has shown that entirely too many poorly selected and poorly handled seed are sold each year. For in-

stance a variety of short staple cotton which is mixed with large and small bolled, or late and early plants indicates that little care has been used in selecting and handling the seed. The occurrence of short staple plants among those of a long staple variety indicates one of two things: either the variety has not been selected sufficiently to be classed as a long staple variety, or little care has been used to prevent mixing or crossing. The frequent occurrence of such undesirable plants shows that proper care has not been taken in the selecting and handling of seed.

### ONE GOOD VARIETY FOR A COMMUNITY.

The best variety of cotton for a community is one that has been chosen on account of its merits and then carefully selected in that community. It is true that certain varieties such as King's Improved, Cook's Improved, Culpepper's Improved, Russell's Big Boll, and Cleveland Big Boll have been grown successfully in most of the cotton growing states. The fact remains, however, that when any one of these varieties is selected in a community it becomes a better variety for that particular community. Several years ago King's Improved was chosen for planting at the Iredell Farm on account of its earliness in that section. Since then the variety has been further improved by field selection. In last year's test it came first in rank of yield, producing 100 pounds of seed cotton per acre more than the next highest variety. Among the other varieties tested were several that had been selected from King's Improved for other localities.

The practice of individual farmers growing two or more varieties of cotton for seed purposes should be discouraged. One good variety properly selected and handled will be worth more to the community than several good varieties. More seedsmen should improve seed with the view of selling them in their immediate communities. If properly selected such seed should be better suited to the local conditions than seed from any other locality. Too often cotton seed are shipped to distant points without consideration of the conditions under which they are to be grown. One of the best recommendations for a grower's improved seed should be the fact that his neighbors are planting them.

BULLETIN 227 APRIL 1914

NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

CONDUCTED JOINTLY BY THE

STATE DEPARTMENT OF AGRICULTURE
AND THE
COLLEGE OF AGRICULTURE AND MECHANIC ARTS

RALEIGH AND WEST RALEIGH

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# FERTILIZER EXPERIMENTS WITH COTTON ON PIEDMONT CECIL SANDY LOAM SOIL

AND

# VARIETIES, CULTURE AND FERTILIZATION OF COTTON ON PIEDMONT CECIL SANDY LOAM AND RED CLAY SOILS

---

Bulletins of the Station Will be Sent Free to Citizens of the State on Request

# THE NORTH CAROLINA
# AGRICULTURAL EXPERIMENT STATION

CONDUCTED JOINTLY BY THE

## STATE DEPARTMENT OF AGRICULTURE

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1In coöperation with the U. S. Department of Agriculture, Bureau of Plant Industry.
2In coöperation with the U. S. Department of Agriculture, Bureau of Soils.
3In coöperation with the U. S. Department of Agriculture, Bureau of Animal Industry.
4In coöperation with the U. S. Department of Agriculture, Office of Experiment Stations.

## INTRODUCTORY STATEMENT

In 1900 plans were made and work begun in a systematic study of the soils of the State, including soil survey, soil analyses, field experiments to determine the adaptability of the different crops to the different type soils, and experiments to determine the fertilizer or plant food requirements of various crops on different soils. The plans were carefully matured, made uniform and have been carried out on the Experiment Station Farm at Raleigh, and on the several test farms located on the main type soils of the State.

This report covers experiments with cotton on the Experiment Station Farm, for the years 1902-09, inclusive, together with a discussion of the results. C. B. Williams and B. W. Kilgore, are responsible for the plans and conduct of the work in 1903-07; and C. B. Williams in 1907-09. B. F. Walton, William Kerr and A. R. Russell, successively as superintendents of the Station Farm, have had charge of the culture and handling of the crop, and W. F. Pate and F. N. McDowell have rendered valuable aid in putting the results in tabular form. C. B. Williams is responsible for the form of the report, and conclusions and writing of it.

Under this plan the following reports have been issued:

(1) Preliminary Report on the Soil Survey Work in the State, and Fertilizer, Culture and Variety Tests of Cotton, Corn, Irish and Sweet Potatoes, Grasses and Grains. (Edgecombe Test Farm. Department of Agriculture Bulletin, November, 1900.)

(2) Fertilizer, Culture and Variety Tests of Cotton and Corn, and Experiments on Black or Pocosin Soils. (Edgecombe Test Farm. Department of Agriculture Bulletin, January, 1902.)

(3) Fertilizer Experiments with Cow Peas on Piedmont Red Clay Loam Soil, and Varieties and Culture of the Cow Pea on this Soil. (Iredell Test Farm. Department of Agriculture Bulletin, June, 1910.)

(4) Fertilizer Experiments with Cotton on the Piedmont Red Clay Loam Soil, and Varieties and Culture of Cotton on this Soil. (Iredell Test Farm. Department of Agriculture Bulletin, No. 139, August, 1910.)

(5) Fertilizer Experiments with Corn on the Piedmont Red Clay Loam Soil, and Varieties and Culture of Corn on this Soil. (Iredell Test Farm. Department of Agriculture Bulletin, No. 140, September, 1910.)

(6) A Preliminary Report on the Mountain Soils. (Department of Agriculture Bulletin, No. 151, May, 1911.)

(7) Fertilizer Experiments with Cotton on Norfolk Sandy Loam Soil, and Varieties and Culture of Cotton on this Soil. (Edgecombe Test Farm. Department of Agriculture Bulletin, No. 195, April, 1914.

# I. FERTILIZER EXPERIMENTS WITH COTTON ON PIEDMONT CECIL SANDY LOAM SOIL

AND

# II. VARITIES, CULTURE AND FERTILIZATION OF COTTON ON PIEDMONT CECIL SANDY LOAM AND RED CLAY SOILS

**Being a Report of Work with Cotton on the Experiment Station Farm in 1902-09, Inclusive**

By C. B. Williams, B. W. Kilgore, and A. R. Russell

## General Summary of Results of Fertilizer Tests.

1. The proper fertilization of cotton pays large profits, larger ones than any other staple crop generally grown in the State. What this fertilization should be on this and similar soils is shown by the results of our experiments as given on the following pages.

2. For the production of cotton on this land the use of a mixture carrying normal amounts of phosphoric acid and nitrogen gave an average increased yield of seed cotton per acre of 43 per cent. over the yield secured on the same character of land without fertilization. The net profit over cost of fertilizer of this combination was $15.14 per acre.

3. Where a normal amount of potash was used with the phosphoric acid in place of the nitrogen there was an average increase in yield of 46 per cent. of seed cotton and an average profit, over cost of fertilizer used, of $19.17 per acre.

4. The use of a fertilizer mixture carrying normal amounts of nitrogen and potash was far less effective and profitable than when mixtures containing normal amounts of phosphoric acid and nitrogen and phosphoric acid and potash were used. The average profit per acre from the use of a mixture containing potash and nitrogen alone was only $4.84 per acre, after deducting the cost of the materials supplying these plant food constituents.

5. Nitrogen, phosphoric acid, and potash combined in a complete fertilizer yielded on an average only slightly more than when nitrogen was left out of the mixture.

The experiments as a whole show that phosphoric acid is the predominant or controlling constituent for increasing yields and adding to profits in growing cotton on this soil. It would appear from the average results that potash in the quantities used was a little more effective than was the nitrogen in the quantity used.

6. The average results show that lime alone was used at a very small profit, while in combination with nitrogen, phosphoric acid and potash

to make a complete fertilizer, it has shown up on an average to a slightly better advantage. Taking all the results as a whole, the indications are that in growing cotton on this soil under similar conditions to those obtaining in these experiments, lime does not seem to be especially beneficial in cotton production.

7. The amount of nitrogen in the normal fertilizer (400 pounds per acre), applied in the cotton experiments, was 2½ per cent., or 10 pounds to the acre. This amount was varied so as to give 5, 10, 20 and 30 pounds of nitrogen per acre. The yields and profits did not increase for the larger quantities of nitrogen. On an average, slightly the largest profit was obtained from the use of 10 and 20 pounds of nitrogen per acre with normal amounts of phosphoric acid and potash. Ten pounds of nitrogen would be supplied by 77 pounds of 13 per cent. dried blood, and 20 pounds by 154 pounds of blood.

8. The amount of phosphoric acid in the normal fertilizer (400 pounds per acre) was 7 per cent., or 28 pounds per acre. This quantity was varied so as to apply 14, 28, 56 and 84 pounds, respectively, of phosphoric acid per acre. The largest and most profitable yields were secured from 56 pounds and 84 pounds per acre, when used with normal amounts of nitrogen and potash. These amounts of phosphoric acid would be supplied by 87.5, 175, 350 and 525 pounds respectively of 16 per cent. acid phosphate.

9. The amount of potash in the normal fertilizer (400 pounds per acre) used, was 2½ per cent. or 10 pounds per acre. Varying this amount so as to apply 5, 10, 20 and 30 pounds per acre, respectively, showed as an average of the results that 5 and 20 pounds of potash per acre, or 1¼ and 5 per cent. in the mixture, gave the most profitable returns. Five pounds of potash would be supplied by 25 pounds of 20 per cent. manure salt and 20 pounds by 100 pounds of manure salt. Taking all the results from both fields as a whole, it would appear, as the use of 20 pounds of potash only gave an average annual profit of 57 cents more per acre than when 5 pounds of potash per acre was used in the mixture, that for cotton on this land not more than 1 to 2 per cent. of potash need generally be added to a normal mixture of phosphoric acid and nitrogen.

10. Varying the amounts of the normal fertilizer application from 200 to 1,200 pounds per acre gave increased yield and profits for all the applications. The most profitable application was at the rate of 600 pounds per acre of the mixture. After deducting the cost of fertilizer, the different quantities per acre showed the following net profits:

| | | |
|---|---|---|
| 200 | pounds of fertilizer per acre gave a profit of | $16.12; |
| 400 | pounds of fertilizer per acre gave a profit of | 19.57; |
| 600 | pounds of fertilizer per acre gave a profit of | 25.50; |
| 800 | pounds of fertilizer per acre gave a profit of | 22.01; |
| 1,200 | pounds of fertilizer per acre gave a profit of | 22.04. |

Putting this in a slightly different way, the first 200 pounds of fertilizer yielded a net profit (after paying for cost of fertilizer) of $8.06 for each 100 pounds of fertilizer; the application of 400 pounds yielded $4.89 per 100 pounds; 600 pounds yielded $4.25 per 100 pounds; 800

pounds yielded $2.75 per 100 pounds, and 1,200 pounds yielded a profit of $1.84 per 100 pounds of fertilizer.

11. Comparisons of dried blood, nitrate of soda, cotton seed and stable manure as sources of nitrogen show no special advantage one over the other in the production of cotton on this soil, except in the case of cotton seed, which showed up decidedly inferior to the others as a carrier of nitrogen. In the tests, nitrate of soda was applied, one-half at planting and one-half about July 1, on one plat; one-half was applied about July 1, the other half of the nitrogen coming from dried blood, which was applied before planting, on another plat, and on a third plat nitrate of soda furnished one-fifth of the nitrogen, the balance coming from dried blood, all being applied before planting. The blood was applied one-half at planting and one-half about July 1 on one plat; one-half at planting, the rest of the nitrogen coming from nitrate of soda, which was applied July 1 on another plat, and on a third plat four-fifths of the nitrogen was supplied by blood and one-fifth by nitrate of soda. Slightly the largest profit per acre was secured by applying all the nitrogen along with the phosphoric acid and potash before planting, having four-fifths of it derived from dried blood and one-fifth from nitrate of soda. The average results do not seem to justify the trouble and expense of dividing the application of nitrogen on this type of soil for cotton and applying one-half at or just before planting, and reserving the remaining one-half to be applied later after the plants have gotten well started in their growth. It is possible that nitrate of soda as the sole source of nitrogen, put out before planting, will give as good results as where a part of the nitrogen comes from blood; but this was not tested.

12. When 400 pounds of the normal fertilizer mixture were each applied before planting in the drill at the ordinary depth, in the drill at three times the ordinary depth below the seed, broadcast before planting, and divided into two equal parts, one-half being applied in the drill before planting and the other half as a side dressing about July 1, the most profitable method, everything considered, of applying the fertilizer mixture, the results would seem to indicate, would be in the drill at planting time at the ordinary depth. Dividing the application, putting in one-half at planting and reserving the other one-half and applying as a side dressing about July 1, produced $2.13 less profit per acre on an average of the results of the two fields than was secured when all the fertilizer was applied in the drill at the ordinary depth at planting. Applying the fertilizer broadcast at planting was annually $2.67 per acre less profitable than when the fertilizer was applied in the drill at planting in the ordinary way.

13. For the conditions prevailing and the length of time covered by the experiments comparing the relative value of acid phosphate, basic slag and finely ground phosphate rock, the former material was found to be decidedly the most efficient and profitable carrier of phosphoric acid for cotton.

14. Where 400 pounds is used to the acre the best and most economical method of application is in the drill before planting.

15. Our soil analyses of the various soils of the State indicate that

these results will apply to the red (cecil) clay loams and red (cecil) clay soils of the Piedmont section of the State.

16. For the production of cotton on these soils, taking the results here reported as a whole, it is recommended that at least 400 pounds of fertilizer be used, and as much more as can be afforded up to 600 pounds per acre. The fertilizer can be most profitably applied in the drill before planting, though there is no objection to dividing the application into two parts, putting out one-half in the drill before planting and the other half as a side dressing about July 1, according to season. The fertilizer mixture should contain about 10 per cent. phosphoric acid and 2 per cent. each of nitrogen and potash. The nitrogen may be all derived from blood, tankage, cottonseed meal, or similar products, or in part from one or all of these, and in part (up to one-half) from nitrate of soda.

Kainit, manure salt, sulphate or muriate of potash may furnish the potash, and acid phosphate the phosphoric acid.

Four hundred pounds of the above mixture would contain 40 pounds of available phosphoric acid and 8 pounds each of nitrogen and potash, and 600 pounds would contain 60 pounds of available phosphoric acid and 12 pounds each of nitrogen and potash. The required amounts of phosphoric acid in 400 and 600 pounds, respectively, of this mixture would be supplied by 250 pounds and 375 pounds of 16 per cent. acid phosphate; the nitrogen by 61.5 pounds and 92.3 pounds of 13 per cent. dried blood; and the potash by 40 pounds and 60 pounds of manure salt. Other materials or other grades of these same materials may be used, and it will not be difficult, knowing just what they contain, to use such quantities of them as will be necessary to furnish the quantities of plant food, having in mind that it is the specific number of pounds of phosphoric acid, nitrogen and potash that is desired, rather than a given weight of mixed fertilizer.

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## I. Fertilizer Experiments with Cotton on Piedmont Cecil Sandy Loam Soil

This is the first for the Central Farm at West Raleigh, of a series of bulletins giving the results of experiments to determine the fertilizer needs of different crops on different types of soils. Other reports of field tests with different combinations and amounts of commercial fertilizer per acre have been issued, giving the results with cow peas, cotton and corn grown on the Iredell and Edgecombe test farms, for a sufficient number of years in order that reliable practical deductions, with reference to the most economical fertilization of these crops may be made from the results.

### Work Reported.

Cotton is our leading money crop. More commercial fertilizer is used in fertilizing and growing this crop than any other. It responds readily and profitably to proper fertilization. Some twelve years ago systematic experiments were begun to determine the fertilizer or plant-

food requirements for the most economical production of cotton on our different cotton soils.

On the following pages are recorded the results of eight years' fertilizer and variety tests of cotton on the Experiment Station Farm for the years 1902-09, inclusive. The work is being continued to collect further data, when cotton is grown as it has been in the work here recorded, as well as in rotations with other staple crops and soil-improving crops.

## LOCATION OF FARM AND CHARACTER OF SOIL.

This farm lies about two miles south of Raleigh and is elevated about 400 feet above sea level. The soil is made up largely of Cecil sandy loam. This is a brownish sandy-clay loam about 7 to 10 inches deep, and overlying a red-clay subsoil, both of which contain from twenty to thirty per cent. of medium to coarse rock fragments. The main types of soil in the Piedmont are cecil sandy loam (gray land), red (cecil) clay loam, and red (cecil) clay, the latter two being the predominating types. The clay and clay-loam types are rich in potash, very poor in phosphoric acid, the amount of nitrogen depending on the organic matter in the soil. Analyses of samples of soil from the unfertilized plats on which these experiments were conducted, show that the soil contains on an average about the following number of pounds of plant food per acre in the surface soil (taken to a depth of 6⅔ inches, and estimated to weigh two million pounds to the acre) and in the subsoil (taken to an additional depth of 28 inches, and estimated to weigh eight million pounds per acre):

| | Surface Soil 6⅔ Inches | Subsoil 28 Inches |
|---|---|---|
| Nitrogen (N) | 778 | 2,068 |
| Phosphoric Acid ($P_2O_5$) | 515 | 4,120 |
| Potash ($K_2O$) | 3,041 | 19,172 |
| Lime (CaO) | 5,530 | 26,420 |

## THE PLATS.

The plats on which these experiments were conducted were embraced in Fields A and B. Fields A and B were badly run down when the experiments were started in 1902. The plats in Field A were laid off in two series parallel to each other, there being sixteen plats to the series, and the plats of the two series joining directly on to each other without any driveway or turn row between the series. At the east end of the first series, and at the west end of the second series, there is an 8 or 10 foot driveway. The plats are one-twentieth acre in size and measure 132 feet long and 16½ feet wide. There is neither a row nor extra space between the plats in the different series. Field B lies immediately south of Field A, and the plats of this field are laid out in a similar manner and of the same size as those of Field A.

*Field A.* The plats of this field were used for fertilizer experiments with cotton in 1902, 1903, 1904, 1906 and 1908; and for fertilizer tests with corn in 1905, 1907 and 1909. In case of each of the three crops the same plan or system of fertilization was followed. By this is meant that plat one in all cases received nitrogen and phosphoric

acid, plat two nitrogen and potash, plat three phosphoric acid and potash, and so on, though the quantities actually applied varied with the crops. The fertilization of the cotton plats was based on a normal application of 400 pounds per acre of a mixture containing 7 per cent. available phosphoric acid, and 2½ per cent. each of nitrogen and potash. The fertilization for corn was on basis of 300 pounds per acre of a mixture containing 7 per cent. available phosphoric acid, 3 per cent. nitrogen and 1½ per cent. potash.

*Field B.* These plats were used for fertilizer experiments with corn in 1902, 1903, 1904, 1906 and 1908; and for the experiments with cotton in 1905, 1907 and 1909. In this field the same combinations of fertilizer went on the same plats each year for the corn and cotton, but the proportions of the plant-food constituents were varied for the two crops, as was done on Field A.

### Preparation and Cultivation.

The land in all cases was well prepared by breaking with a two-horse turning plow in the winter, usually in January and February, to a depth of 8 to 10 inches, and allowed to remain this way until just before planting, when it was cut up thoroughly with a disk harrow. The rows were run off 3 feet 3.6 inches apart, the fertilizer was distributed in the drill and covered to a slight ridge, usually with one furrow of a disk or other cultivator. This was done some time prior to planting, so as to give the ground time to settle before planting. Culpepper's Improved variety was used and was planted as soon as the weather would permit in the spring, on the slight ridge made in covering the fertilizer, but which was usually brought to a level, or almost to a level, by the cotton planter. The cotton was well cultivated with weeders, harrows, Planet Jr., and two-horse cultivators, requiring not exceeding two furrows to the row, making the cultivation deep at beginning and shallow toward the close of the season, when root development of the plants was well extended into the soil. The cultivation was repeated each ten days to two weeks during the season, the crop being laid by between July 15 and August 10, according to season. The cotton was thinned as nearly as possible to one stalk in the hill every 15 inches.

### Fertilization and Fertilizer Materials Used.

As already stated, the fertilizer was applied in the drill just before planting the cotton, the exact quantity of material for each row being weighed out separately so that each row would get its proper amount of the several fertilizer constituents. Acid phosphate was used as the source of phosphoric acid, except on those plats where different carriers of phosphoric acid was compared; dried blood as the source of nitrogen, except where there was a comparison of different nitrogen-furnishing materials, or where nitrate of soda was used as a part of the nitrogen; manure salt as the source of potash, and rock or building lime for lime. The fertilizer materials were analyzed each year and applications made on basis of actual analyses, so as to give the exact quantities of nitrogen, phosphoric acid, and potash indicated for each plat. For the sake of simplicity and convenience in presenting the results of a

number of years' experiments, the fertilizer applications are expressed in terms of acid phosphate containing 16 per cent. available phosphoric acid, dried blood containing 13 per cent. nitrogen, nitrate of soda containing 14.8 per cent. nitrogen, and manure salt containing 20 per cent. potash, which figures represent the average composition of these materials. The fertilizer applications in the fertilizer experiments are on basis of 400 pounds per acre for the normal plat (NPK) of a mixture containing 7 per cent. available phosphoric acid and 2½ per cent. each of nitrogen and potash. Lime is applied at the rate of 500 pounds rock or building lime, or 1,000 pounds slaked lime. The fertilizer applications in the tables, in addition to being represented in terms of acid phosphate, dried blood, nitrate of soda, and manure salt, are also expressed in terms of the symbols, NPK and L, which have the following significance:

N equals nitrogen at the rate of 10 pounds per acre, or 77 pounds of 13 per cent. dried blood;
P equals phosphoric acid at the rate of 28 pounds per acre, or 175 pounds of 16 per cent. acid phosphate;
K equals potash at the rate of 10 pounds per acre, or 50 pounds 20 per cent. manure salt;
L equals lime at the rate of 500 pounds rock or 1,000 pounds slaked lime per acre.

There are columns in the tables showing the exact weights in pounds of phosphoric acid, nitrogen and potash applied to each plat (expressed on acre basis), which will enable anyone to use these same amounts of fertilizer constituents in other materials if desired.

The following average prices per ton, which fairly represent the cost of the several materials to the farmer for the period under experimentation have been assumed for the materials used:

| | |
|---|---|
| Acid Phosphate, 16 per cent | $14.00 |
| Dried Blood, 13 per cent | 60.00 |
| Nitrate of Soda, 14.8 per cent. nitrogen | 50.00 |
| Manure Salt, 20 per cent | 20.00 |
| Rock Lime | 10.00 |

The arrangements of the plats and the scheme of fertilizer application is shown by the following:

Normal fertilizer application, 400 pounds per acre of mixture containing—

| | |
|---|---|
| Phosphoric Acid | 7 per cent. |
| Nitrogen | 2½ per cent. |
| Potash | 2½ per cent. |

In this normal application—

N equals 10 pounds nitrogen, equals 77 pounds 13 per cent. dried blood;
P equals 28 pounds phosphoric acid, equals 175 pounds 16 per cent. acid phosphate;
K equals 10 pounds potash, equals 50 pounds 20 per cent. manure salt.

Size of Plat, One-Twentieth Acre.

(152x16½ feet).

| First Series | Application |
|---|---|
| 1 | N P |
| 2 | N K |
| 3 | P K |
| 4 | O |
| 5 | N P K |
| 6 | N½ P K |
| 7 | $N_2$ P K |
| 8 | $N_3$ P K |
| 9 | N P½ K |
| 10 | N $P_2$ K |
| 11 | N $P_3$ K |
| 12 | O |
| 13 | N P K½ |
| 14 | N P $K_2$ |
| 15 | N P $K_3$ |
| 16 | ½ (N P K) |

| Second Series | Application | |
|---|---|---|
| $1^2$ | 1½ (N P K) | |
| $2^2$ | 2 (N P K) | |
| $3^2$ | 3 (N P K) | |
| $4^2$ | N P K | Two applications of nitrogen: ½ as blood at planting, ½ as nitrate of soda later. |
| $5^2$ | O | |
| $6^2$ | N P K | Two applications of nitrogen: ½ as nitrate of soda at planting, ½ as nitrate of soda later. |
| $7^2$ | N P K | Two applications of nitrogen: ½ as blood at planting, ½ as blood later. |
| $8^2$ | N P K | Two sources of nitrogen: 1-5 as nitrate of soda at planting, 4-5 as blood at planting. |
| $9^2$ | N P K | All nitrogen derived from cotton seed. |
| $10^2$ | N P K | All nitrogen derived from stable manure. |
| $11^2$ | N P K | Two applications of fertilizer: ½ at planting, ½ later. |
| $12^2$ | Lime | 1,000 pounds slaked lime per acre, broadcast every 4th year. |
| $13^2$ | O | |
| $14^2$ | N P K L | |
| $15^2$ | N P K | Fertilizer applied broadcast. |
| $16^2$ | N P K | Fertilizer applied deep. |

The above represents the plats in Field A. In Field B they are arranged in a similar way.

## Weather Conditions During the Experiments.

Besides soil, seed, fertilization and cultivation, and time of planting, weather conditions, mainly the rainfall, influence the crop yield. In the table presented below will be found the monthly and annual rain-

fall during the years covered by the experiments, the mean monthly and annual rainfall since 1867, and the same data for the months of May to September, inclusive. During the growing months the rainfall in 1902 and 1903 was below normal, and there was an early frost in 1903, 1906 and 1907; good conditions prevailed in 1904; and in 1905 and 1908 there was more than a normal amount of rainfall. The rainfall throughout 1909 was low but for the growing season it was about normal. The year 1908 was noted for its heavy rainfalls.

RAINFALL IN INCHES AT RALEIGH.

| | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | 1908 | 1909 | Means of Observations, 1867-1908. |
|---|---|---|---|---|---|---|---|---|---|
| January | 2.39 | 3.04 | 2.80 | 2.37 | 3.67 | 1.23 | 4.26 | 1.90 | 3.12 |
| February | 7.08 | 6.67 | 4.22 | 6.05 | 3.74 | 4.26 | 3.66 | 3.14 | 4.24 |
| March | 2.14 | 7.32 | 3.55 | 3.39 | 5.35 | 3.38 | 5.58 | 2.77 | 4.19 |
| April | 3.10 | 5.92 | 0.29 | 5.01 | 0.73 | 3.63 | 2.56 | 4.08 | 3.41 |
| May | 2.00 | 2.67 | 2.76 | 7.76 | 1.73 | 4.75 | 2.03 | 2.92 | 4.57 |
| June | 3.04 | 4.61 | 6.64 | 1.72 | 4.96 | 6.73 | 6.20 | 5.73 | 4.57 |
| July | 3.39 | 4.41 | 3.48 | 7.65 | 5.35 | 1.42 | 6.14 | 6.84 | 5.43 |
| August | 2.78 | 1.60 | 1.51 | 7.33 | 8.28 | 2.96 | 13.63 | 4.40 | 6.14 |
| September | 2.92 | 1.43 | 5.23 | 1.43 | 3.29 | 6.13 | 3.70 | 4.52 | 3.71 |
| October | 3.07 | 5.28 | 2.70 | 2.05 | 2.63 | 0.22 | 3.76 | 1.52 | 3.12 |
| November | 4.12 | 0.88 | 5.13 | 0.66 | 0.69 | 5.29 | 1.47 | 0.11 | 2.42 |
| December | 3.15 | 2.21 | 3.02 | 6.52 | 2.92 | 7.78 | 3.64 | 1.89 | 3.18 |
| Annual | 39.16 | 48.04 | 45.33 | 51.96 | 43.34 | 47.78 | 56.63 | 39.82 | 48.10 |
| Total for growing season, May to Sept., inclusive | 14.11 | 16.72 | 23.62 | 25.89 | 23.61 | 21.99 | 31.70 | 24.41 | 24.42 |

## METHOD OF DETERMINING THE EFFECTS OF THE DIFFERENT FERTILIZER MIXTURES.

In Field A there was considerable difference between the average yields secured from the different unfertilized plats. These differences were largely due to the natural lay of the land on which the plats were laid out in this field. Plat 12 was at the top of the hill and the land sloped slightly in both directions from this plat, the greatest slope being in the direction of unfertilized plat 4. As the slope in each direction and the increase in natural productivity of the land from plat 12 seemed to be uniformly gradual, the following formula was devised and used in securing the average annual increase in yield of seed cotton per acre on both of the fields where the fertilized plats had unfertilized plats on both sides of them; but where there was an unfertilized plat only on one side, the effect of the fertilizer applied to that particular plat was determined by direct subtraction of the yield of the nearest unfertilized plat in the series in the field from the particular plat under consideration.

The measure of the effect of the fertilizer mixture applied to any plat is equal to the total yield on that plat decreased by the yield of the first unfertilized plat of the group, and further increased or de-

creased (according as the unfertilized yield decreases or increases from first to last plat of the group) by the product of the difference in yield of the first and the last unfertilized plats of the group by the ratio of the position of the plat in the group to the whole number of plats.

For example—

Let E =True measure of the effect of fertilizer mixture applied.
T =Total yield of plat under consideration.
A =Yield first unfertilized plat.
B =Yield of last unfertilized plat in the group.
$N_2$=No. of the last plat in group.
$N_1$=No. of the first plat in group.
N =No. of the plat to which correction is to be applied.

Then

$$E=T-A-\frac{N-N_1}{N_2-N_1}(B-A)$$

## The Results.

In studying the yields of the two fields it is well to bear in mind that cotton was grown continuously in Field A and corn in Field B during 1902, 1903, and 1904, but after this these crops were grown in alternate years on the two fields. Since 1904, with one or two years exceptions, a leguminous crop has been seeded on each of the two fields either in the crop, as was the case with cowpeas in corn some little time before last cultivation of the corn, or after the first of September when crimson or bur clover was seeded in the crops of corn and cotton growing on the two fields. None of the leguminous catch crops for the period covered in the report made sufficient growth on the different plats of the two fields to amount to much in the way of adding humus and nitrogen to the soil, largely because of the rather bad mechanical condition of the soil, which made it very difficult to secure and maintain a satisfactory stand of these catch crops on the different plats of the two fields. Since 1909 barnyard manure has been added in equal quantities to all the plats in both of the fields. The addition of a relatively small amount of manure to the different plats, the soil of which before was very deficient in organic matter, has had a rather marked effect in securing a better stand and more satisfactory growth of the catch crops grown on the plats of the two fields between the plantings of cotton and corn. From these results and other observations it would appear to be that some soils are so deficient in organic matter and have gotten into such a run-down condition generally that it would seem that one of the most practical ways to enliven them and fit them for growing leguminous cover crops would be to give them a fairly liberal coating of barnyard manure.

Until organic matter has been embodied in this soil, it tends strongly to run together after every rain and a moist condition of the soil favorable to germination of the seed and subsequent growth of the young plants is most difficult to secure and maintain in the summer and in early fall for the leguminous crops that may be put in the rotation, such as cowpeas, crimson clover, bur clover, or hairy vetch.

In the future, as during the past three years (1911-1913), the crops will be grown according to the following rotation:

First year .....Cotton, and rye and crimson clover.
Second year .....Corn and rye.

Each crop has been and will be in the future fertilized according to the scheme outlined in the fertilizer experiments for cotton and corn.

The experiments were planned to cover the culture and fertilization of cotton as a whole, but the results of the several sub-divisions or phases of the subject are grouped in short tables to facilitate examination and the drawing of conclusions, after which they will be considered as a whole and general conclusions drawn for the fertilization of the crop on this type of soil.

TABLE I—RESULTS OF FERTILIZER EXPERIMENTS WITH COTTON: EFFECT OF NITROGEN, PHOSPHORIC ACID, POTASH, AND LIME IN SINGLE COMBINATIONS AND IN COMBINATIONS TO MAKE COMPLETE FERTILIZER.

RESULTS IN FIELD A IN 1902, 1903, 1904, 1906 AND 1908.

| Number of Plat | Fertilizer Application Per Acre | Pounds of Nitrogen (N) Per Acre | Pounds of Phosphoric Acid ($P_2O_5$) Per Acre | Pounds of Potash ($K_2O$) Per Acre | Yield of Seed Cotton in Pounds Per Acre | | | | | | | | Average Yield of Seed Cotton in Pounds Per Acre | Average Increase Per Acre Due to Fertilizer | Value of Increase at 4.5 Cents Per Pound | Cost of Fertilizer Per Acre | Average Value of Increase Over Cost of Fertilizer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | 1908 | 1909 | | | | | |
| 4 | Unfertilized.....O | | | | 1229.0 | 903.0 | 970.0 | | 552.6 | | 487.6 | | 828.4 | | $ | $ | $ |
| 1 | 77 lbs. 13% blood.....N | 10 | | | 1405.2 | 1143.6 | 1276.2 | | 1082.6 | | 865.0 | | 1154.5 | 326.1 | 14.67 | 3.54 | 11.13 |
| | 175 lbs. 16% acid phosphate.....P | | 28 | | | | | | | | | | | | | | |
| 2 | 77 lbs. 13% blood.....N | 10 | | | 1405.4 | 1084.2 | 1048.0 | | 745.2 | | 690.0 | | 994.6 | 166.2 | 7.48 | 2.81 | 4.67 |
| | 50 lbs. 20% manure salt.....K | | | 10 | | | | | | | | | | | | | |
| 3 | 175 lbs. 16% acid phosphate.....P | | 28 | | 1577.6 | 1118.2 | 1194.4 | | 940.0 | | 800.0 | | 1126.0 | 297.6 | 13.39 | 1.73 | 11.66 |
| | 50 lbs. 20% manure salt.....K | | | 10 | | | | | | | | | | | | | |
| 4 | Unfertilized.....O | | | | 1229.0 | 903.0 | 970.0 | | 552.6 | | 487.6 | | 828.4 | | | | |
| 5 | 77 lbs. 13% blood.....N | 10 | | | 1412.0 | 1021.8 | 1230.0 | | 1150.0 | | 840.0 | | 1130.8 | 387.5 | 17.44 | 4.04 | 13.40 |
| | 175 lbs. 16% acid phosphate.....P | | 28 | | | | | | | | | | | | | | |
| | 50 lbs. 20% manure salt.....K | | | 10 | | | | | | | | | | | | | |
| 12 | Unfertilized.....O | | | | 144.6 | 211.2 | 221.2 | | 112.6 | | 50.0 | | 147.9 | | | | |
| 5[2] | Unfertilized.....O | | | | 859.6 | 668.2 | 666.8 | | 512.6 | | 317.6 | | 605.0 | | | | |
| 12[2] | 500 lbs. unslaked lime every fourth year.....L | | | | 998.8 | 748.2 | 725.4 | | 400.2 | | 225.0 | | 619.5 | 41.4 | 1.86 | 0.63 | 1.23 |
| 13[2] | Unfertilized.....O | | | | 910.6 | 775.0 | 703.2 | | 390.2 | | 92.6 | | 574.3 | | | | |
| 13[2] | Unfertilized.....O | | | | 910.6 | 775.0 | 703.2 | | 390.2 | | 92.6 | | 574.3 | | | | |
| 14[2](1) | 77 lbs. 13% blood.....N | 10 | | | 1217.4 | 1028.2 | 1012.6 | | 1047.6 | | 730.0 | | 1007.2 | 472.4 | 21.26 | 4.67 | 16.59 |
| | 175 lbs. 16% acid phosphate.....P | | 28 | | | | | | | | | | | | | | |
| | 50 lbs. 20% manure salt.....K | | | 10 | | | | | | | | | | | | | |
| | 500 lbs. unslaked lime every fourth year.....L | | | | | | | | | | | | | | | | |
| 19[2] | Unfertilized.....O | | | | 383.8 | 374.4 | 442.6 | | | | | | | | | | |

## Results in Field B in 1905, 1907, and 1909.

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 77 lbs. 13% blood ..... N<br>175 lbs. 16% acid phosphate ..... P | 10 | 28 | | | | | 1159.6 | 580.0 | 565.0 | 768.2 | 504.1 | 22.68 | 3.54 | 19.14 |
| 2 | 77 lbs. 13% blood ..... N<br>50 lbs. 20% manure salt ..... K | 10 | | 10 | | | | 738.2 | 360.0 | 215.0 | 437.7 | 173.6 | 7.81 | 2.81 | 5.00 |
| 3 | 175 lbs. 16% acid phosphate ..... P<br>50 lbs. 20% manure salt ..... K | | 28 | 10 | | | | 1260.8 | 755.0 | 670.0 | 895.3 | 631.2 | 28.40 | 1.73 | 26.67 |
| 4 | 77 lbs. 13% blood ..... N<br>175 lbs. 16% acid phosphate ..... P<br>50 lbs. 20% manure salt ..... K | 10 | 28 | 10 | | | | 1312.0 | 755.0 | 710.0 | 925.7 | 661.6 | 29.77 | 4.04 | 25.73 |
| 5 | Unfertilized ..... O | | | | | | | 447.4 | 185.0 | 160.0 | 264.1 | | | | |
| 4[2] | Unfertilized ..... O | | | | | | | 431.8 | 200.0 | 165.0 | 265.6 | | | | |
| 11[2] | 500 lbs. unslaked lime every fourth year ..... L | | | | | | | 520.2 | 215.0 | 225.0 | 320.1 | 22.4 | 1.01 | 0.63 | 0.38 |
| 12[2] | 77 lbs. 13% blood ..... N<br>175 lbs. 16% acid phosphate ..... P<br>50 lbs. 20% manure salt ..... K<br>500 lbs. unslaked lime every fourth year ..... L | 10 | 28 | 10 | | | | 1350.8 | 705.0 | 870.0 | 975.3 | 673.0 | 30.29 | 4.67 | 25.62 |
| 14[2] | Unfertilized ..... O | | | | | | | 534.4 | 180.0 | 220.0 | 311.5 | | | | |

TABLE I—Continued.

Average Results for Eight Years on Fields A and B.

| Number of Plat | Fertilizer Application Per acre | | Pounds of Nitrogen (N) Per Acre | Pounds of Phosphoric Acid ($P_2O_5$) Per Acre | Pounds of Potash ($K_2O$) Per Acre | Yield of Seed Cotton in Pounds Per Acre 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | 1908 | 1909 | Average Yield of Seed Cotton in Pounds Per Acre | Average Increase Per Acre Due to Fertilizer | Value of Increase at 4.5 Cents Per Pound | Cost of Fertilizer Per Acre | Average Value of Increase Over Cost of Fertilizer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-5 | Unfertilized | O | | | | | | | | | | | | | | $ | $ | $ |
| 1-1 | 77 lbs. 13% blood | N | 10 | | | | | | | | | | | 961.4 | 415.1 | 18.68 | 3.54 | 15.14 |
| | 175 lbs. 16% acid phosphate | P | | 28 | | | | | | | | | | | | | | |
| 2-2 | 77 lbs. 13% blood | N | 10 | | | | | | | | | | | 716.2 | 169.9 | 7.65 | 2.81 | 4.84 |
| | 50 lbs. 20% manure salt | K | | | 10 | | | | | | | | | | | | | |
| 3-3 | 175 lbs. 16% acid phosphate | P | | 28 | | | | | | | | | | 1010.7 | 464.4 | 20.90 | 1.73 | 19.17 |
| | 50 lbs. 20% manure salt | K | | | 10 | | | | | | | | | | | | | |
| (4+12)—15 | Unfertilized | O | | | | | | | | | | | | | | | | |
| 5-4 | 77 lbs. 13% blood | N | 10 | | | | | | | | | | | 1028.3 | 524.6 | 23.61 | 4.04 | 19.57 |
| | 175 lbs. 16% acid phosphate | P | | 28 | | | | | | | | | | | | | | |
| | 50 lbs. 20% manure salt | K | | | 10 | | | | | | | | | | | | | |
| ($5^2$+$13^2$)— ($4^2$+$14^2$) $12^2$—$11^2$ | Unfertilized | O | | | | | | | | | | | | | | | | |
| | 500 lbs. unslaked lime every fourth year | L | | | | | | | | | | | | 469.8 | 31.9 | 1.44 | 0.63 | 0.81 |
| ($13^2$+$19^2$)— ($4^2$+$14^2$) | Unfertilized | O | | | | | | | | | | | | | | | | |
| $14^2$—$12^2$ | 77 lbs. 13% blood | N | 10 | | | | | | | | | | | 991.3 | 572.7 | 25.78 | 4.67 | 21.11 |
| | 175 lbs. 16% acid phosphate | P | | 28 | | | | | | | | | | | | | | |
| | 50 lbs. 20% manure salt | K | | | 10 | | | | | | | | | | | | | |
| | 500 lbs. unslaked lime every fourth year | L | | | | | | | | | | | | | | | | |

(1)In determining the "Average Increase per Acre Due to Fertilizer" for plat $14^2$, Field A, the formula given on page 14 was used for 1902, 1903 and 1904 as there were unfertilized plats ($13^2$ and $19^2$) on either side, but during 1906 and 1908 for Field A the annual increase was secured by simply subtracting the yield of Plat $13^2$ from Plat $14^2$ as cotton was not grown on Plat $19^2$ after 1904. The average of these differences thus obtained is taken as the average increase due to the fertilizer combination applied to Plat $14^2$.

## EFFECT OF NITROGEN, PHOSPHORIC ACID, POTASH AND LIME IN SINGLE COMBINATIONS.

The experiments, the results of which are presented in Table I, were planned to determine the effect upon the yield of cotton when two of the constituents were applied together, as nitrogen and phosphoric acid (N P), nitrogen and potash (N K), and phosphoric acid and potash (P K), and when all three of the fertilizing constituents were applied to make a complete fertilizer (N P K); also to test the effect of lime (L) when used alone and when used in connection with a complete fertilizer (N P K L). The results are shown in yields of seed cotton per acre for the several years, average yields, average increases over the unfertilized (O) plats which represent the effect of the fertilizer applications, the value of increase, cost of the fertilizer, and value of the increased yields over cost of fertilizer.

*Nitrogen and Phosphoric Acid,* N P (Plats 1 and 1). Nitrogen and phosphoric acid alone gave increased yields over the unfertilized plats for all eight years on the plats in the two fields, the average annual increase for five years in Field A being 326.1 pounds seed cotton per acre, and for the three years in Field B being 504.1 pounds seed cotton, or an average annual increase for eight years in the two fields of 415.1 pounds per acre, worth $15.14 over the cost of the fertilizer applied.

*Nitrogen and Potash,* N K (Plats 2 and 2). From an application of nitrogen and potash combined there were small average increased yields on the plats of the two fields, the average for the five years being 166.2 pounds seed cotton for field A, and 173.6 pounds as an average of 3 years for field B, or an average annual increase for both fields of 169.9 pounds of seed cotton per acre, worth $4.84 over the cost of fertilizer used.

*Phosphoric Acid and Potash,* P K (Plats 3 and 3). Phosphoric acid and potash combined gave increased yields on all the plats in the two fields, the average annual increase for five years in Field A being 297.6 pounds and for three years in Field B 631.2 pounds; or an average for the eight years in the two fields of 464.4 pounds, worth $19.17 over cost of fertilizer.

*Phosphoric Acid, Potash, and Nitrogen,* N P K (Plats 5 and 4). These three materials combined in a complete fertilizer gave increased yields in all the tests on all the plats in two fields, the average annual increase for five years in Field A being 387.5 pounds of seed cotton per acre, and for three years in Field B being 661.6 pounds, or an average annual increase per acre for the eight years on the two fields of 524.6 pounds of seed cotton per acre, worth $19.57 above cost of fertilizer.

*Lime,* L (Plats $12^2$ and $11^2$). Lime was applied at the rate of 500 pounds of rock or 1,000 pounds slaked lime per acre every fourth year. On plat in Field A during five years there was an average annual increase of 41.4 pounds seed cotton per acre, and on plat in Field B during three years an average increase of 22.4 pounds per acre, or on an average, an annual increase from both of the fields of 31.9 pounds per acre, worth $0.81 annually per acre above the cost of the lime.

*Lime with Complete Fertilizer,* N P K L (Plats $14^2$ and $12^2$). Where lime was used in combination with the three fertilizer constituents there was 84.9 pounds more of seed cotton produced per acre on an average in

Field A than where the normal (N P K) application was used, and on Field B an average of 11.4 pounds more seed cotton per acre, or an annual average 48.1 pounds per acre from the use of lime in connection with the normal application of fertilizer. The average annual increase due to the use of lime was worth $1.54 per acre above cost of the lime.

Taking the experiments as a whole, the average results show the following:

That phosphoric acid is the plant food constituent that gave decidedly the largest increase in yield and the greatest profit per acre.

That potash and nitrogen in the amounts used in the experiments gave only slight increase and profit per acre, the former constituent on an average gave a slightly greater profit per acre than did the latter.

That lime when used alone had very little, if any, effect upon yield, but when applied in connection with a normal (N P K) application of fertilizer there was some better showing for the lime.

The main increased yields and profits, therefore, came from phosphoric acid; the next most profitable constituent was potash, nitrogen in the amount used only showing an average profit per acre above cost of 40 cents for the use of 10 pounds of nitrogen used with 28 pounds of phosphoric acid and 10 pounds of potash.

TABLE II—RESULTS OF FERTILIZER EXPERIMENTS WITH COTTON: EFFECT OF VARYING QUANTITIES OF NITROGEN ON YIELD.

RESULTS IN FIELD A IN 1902, 1903, 1904, 1906 AND 1908.

| Number of Plat | FERTILIZER APPLICATION PER ACRE | Pounds of Nitrogen (N) Per Acre | Pounds of Phosphoric Acid ($P_2O_5$) Per Acre | Pounds of Potash ($K_2O$) Per Acre | YIELD OF SEED COTTON IN POUNDS PER ACRE | | | | | | | | Average Yield of Seed Cotton in Pounds Per Acre | Average Increase Per Acre Due to Fertilizer | Value of Increase at 4.5 Cents Per Pound | Cost of Fertilizer Per Acre | Average Value of Increase Over Cost of Fertilizer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | 1908 | 1909 | | | | | |
| 4 | Unfertilized.....O | | | | 1229.0 | 903.0 | 970.0 | | 552.6 | | 487.6 | | 828.4 | | $ | $ | $ |
| 6 | 38.5 lbs. 13% blood.....½ N<br>175 lbs. 16% acid phosphate.....P<br>50 lbs. 20% manure salt.....K | 5 | 28 | 10 | 1171.4 | 842.4 | 923.2 | | 850.0 | | 580.0 | | 873.4 | 215.1 | 9.68 | 2.88 | 6.80 |
| 5 | 77 lbs. 13% blood.....N<br>175 lbs. 16% acid phosphate.....P<br>50 lbs. 20% manure salt.....K | 10 | 28 | 10 | 1412.0 | 1021.8 | 1230.0 | | 1150.0 | | 840.0 | | 1130.8 | 387.5 | 17.44 | 4.04 | 13.40 |
| 7 | 154 lbs. 13% blood.....2 N<br>175 lbs. 16% acid phosphate.....P<br>50 lbs. 20% manure salt.....K | 20 | 28 | 10 | 1210.6 | 951.2 | 1188.2 | | 902.6 | | 730.0 | | 996.5 | 423.3 | 19.05 | 6.35 | 12.70 |
| 8 | 231 lbs. 13% blood.....3 N<br>175 lbs. 16% acid phosphate.....P<br>50 lbs. 20% manure salt.....K | 30 | 28 | 10 | 1105.0 | 944.2 | 1202.8 | | 980.2 | | 575.0 | | 961.4 | 473.3 | 21.30 | 8.66 | 12.64 |
| 12 | Unfertilized.....O | | | | 144.6 | 211.2 | 221.2 | | 112.6 | | 50.0 | | 147.9 | | | | |

TABLE II—Continued.

Results in Field B in 1905, 1907 and 1909.

| Number of Plat | Fertilizer Application Per Acre | Pounds of Nitrogen (N) Per Acre | Pounds of Phosphoric Acid ($P_2O_5$) Per Acre | Pounds of Potash ($K_2O$) Per Acre | Yield of Seed Cotton in Pounds Per Acre | | | | | | | | Average Yield of Seed Cotton in Pounds Per Acre | Average Increase Per Acre Due to Fertilizer | Value of Increase at 4.5 Cents Per Pound | Cost of Fertilizer Per Acre | Average Value of Increase Over Cost of Fertilizer. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | 1908 | 1909 | | | | | |
| 5 | Unfertilized—O | | | | | | | 447.4 | | 185.0 | | 160.0 | 264.1 | | $ | $ | $ |
| 6 | 38.5 lbs. 13% blood—½ N | 5 | | | | | | 1389.2 | | 665.0 | | 700.0 | 918.1 | 651.9 | 29.34 | 2.88 | 26.46 |
| | 175 lbs. 16% acid phosphate—P | | 28 | | | | | | | | | | | | | | |
| | 50 lbs. 20% manure salt—K | | | 10 | | | | | | | | | | | | | |
| 5 | Unfertilized—O | | | | | | | 447.4 | | 185.0 | | 160.0 | 264.1 | | | | |
| 4 | 77 lbs. 13% blood—N | 10 | | | | | | 1312.0 | | 755.0 | | 710.0 | 925.7 | 661.6 | 29.77 | 4.04 | 25.73 |
| | 175 lbs. 16% acid phosphate—P | | 28 | | | | | | | | | | | | | | |
| | 50 lbs. 20% manure salt—K | | | 10 | | | | | | | | | | | | | |
| 5 | Unfertilized—O | | | | | | | 447.4 | | 185.0 | | 160.0 | 264.1 | | | | |
| 7 | 154 lbs. 13% blood—2 N | 20 | | | | | | 1460.8 | | 760.0 | | 850.0 | 1023.6 | 755.4 | 33.99 | 6.35 | 27.64 |
| | 175 lbs. 16% acid phosphate—P | | 28 | | | | | | | | | | | | | | |
| | 50 lbs. 20% manure salt—K | | | 10 | | | | | | | | | | | | | |
| 8 | 231 lbs. 13% blood—3 N | 30 | | | | | | 1526.4 | | 710.0 | | 855.0 | 1030.5 | 760.2 | 34.21 | 8.66 | 25.55 |
| | 175 lbs. 16% acid phosphate—P | | 28 | | | | | | | | | | | | | | |
| | 50 lbs. 20% manure salt—K | | | 10 | | | | | | | | | | | | | |
| 14 | Unfertilized—O | | | | | | | 563.2 | | 125.0 | | 160.0 | 282.7 | | | | |

AVERAGE RESULTS FOR EIGHT YEARS ON FIELDS A AND B.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4–5 | Unfertilized | O | | | | | | | | | | | |
| 6–6 | 38.5 lbs. 13% blood | ½ N | 5 | | | | | | | | | | |
| | 175 lbs. 16% acid phosphate | P | | 28 | | | | | | | | | |
| | 50 lbs. 20% manure salt | K | | | 10 | | | | | 895.8 | 433.5 | 19.51 | 2.88 | 16.63 |
| (4+12)—5 | Unfertilized | O | | | | | | | | | | | |
| 5–4 | 77 lbs. 13% blood | N | 10 | | | | | | | | | | |
| | 175 lbs. 16% acid phosphate | P | | 28 | | | | | | | | | |
| | 50 lbs. 20% manure salt | K | | | 10 | | | | | 1028.3 | 524.6 | 23.61 | 4.04 | 19.57 |
| 7–7 | 154 lbs. 13% blood | 2 N | 20 | | | | | | | | | | |
| | 175 lbs. 16% acid phosphate | P | | 28 | | | | | | | | | |
| | 50 lbs. 20% manure salt | K | | | 10 | | | | | 1010.1 | 589.4 | 26.52 | 6.35 | 20.17 |
| 8–8 | 231 lbs. 13% blood | 3 N | 30 | | | | | | | | | | |
| | 175 lbs. 16% acid phosphate | P | | 28 | | | | | | | | | |
| | 50 lbs. 20% manure salt | K | | | 10 | | | | | 996.0 | 616.8 | 27.76 | 8.66 | 19.10 |
| 12–14 | Unfertilized | O | | | | | | | | | | | |

### Effect of Varying Quantities of Nitrogen.

These tests (Table II) were planned to determine the effect on the yield of cotton of varying quantities of nitrogen, leaving the phosphoric acid and potash constant. On one plat the nitrogen was reduced to one-half of the normal quantity, making the application 5 pounds of nitrogen per acre or practically 1¼ per cent in the fertilizer mixture. On two of the plats it was increased by 2 and 3 times the normal quantity (10 pounds per acre), making the application 20 and 30 pounds per acre respectively, or on basis of the fertilizer mixture 5 and 7½ per cent. The average results for five years on plats in Field A show the largest profit per acre above cost of fertilizer to be from the fertilizer application containing normal quantity of nitrogen in the several mixtures, while the average results for three years in Field B the greatest profit was from plats receiving a fertilizer application containing twice the normal quantity of nitrogen in the mixture, or 20 pounds of nitrogen per acre.

Taking the eight years experiments together the average annual results show an average increased yield per acre over unfertilized plats of 433.5 pounds of seed cotton, worth $16.63 for the fertilizer application containing one-half normal (5 pounds of nitrogen per acre) quantity of nitrogen; 524.6 pounds, worth $19.57 for the fertilizer containing normal (10 pounds nitrogen per acre) quantity per acre; 589.4 pounds, worth $20.17 for the fertilizer with twice normal (20 pounds nitrogen per acre) quantity nitrogen; and 616.8 pounds, worth $19.10 for the mixture containing three times normal (30 pounds nitrogen per acre) quantity of nitrogen with normal amounts of phosphoric acid and potash.

These results indicate that nitrogen is not the most important or controlling constituent for the production of cotton on this soil and that the most profitable quantity of nitrogen to use per acre lies between 10 and 20 pounds per acre.

TABLE III—RESULTS OF FERTILIZER EXPERIMENTS WITH COTTON: EFFECT OF VARYING QUANTITIES OF PHOSPHORIC ACID ON YIELD.

RESULTS IN FIELD A IN 1902, 1903, 1904, 1906 AND 1908.

| Number of Plat | Fertilizer Application Per acre | Pounds of Nitrogen (N) Per Acre | Pounds of Phosphoric Acid ($P_2O_5$) Per Acre | Pounds of Potash ($K_2O$) Per Acre | Yield of Seed Cotton in Pounds Per Acre 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | 1908 | 1909 | Average Yield of Seed Cotton in Pounds Per Acre | Average Increase Per Acre Due to Fertilizer | Value of Increase at 4.5 Cents Per Pound | Cost of Fertilizer Per Acre | Average Value of Increase Over Cost of Fertilizer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | Unfertilized.....O | | | | 1229.0 | 903.0 | 970.0 | | 552.6 | | 487.6 | | 828.4 | | $ | $ | $ |
| 9 | 77 lbs. 13% blood.....N<br>87.5 lbs. 16% acid phosphate...½ P<br>50 lbs. 20% manure salt.....K | 10 | 14 | 10 | 828.2 | 668.8 | 837.0 | | 657.6 | | 375.0 | | 673.3 | 270.2 | 12.16 | 3.42 | 8.74 |
| 5 | 77 lbs. 13% blood.....N<br>175 lbs. 16% acid phosphate.....P<br>50 lbs. 20% manure salt.....K | 10 | 28 | 10 | 1412.0 | 1021.8 | 1230.0 | | 1150.0 | | 840.0 | | 1130.8 | 387.5 | 17.44 | 4.04 | 13.40 |
| 10 | 77 lbs. 13% blood.....N<br>350 lbs. 16% acid phosphate.....2 P<br>50 lbs. 20% manure salt.....K | 10 | 56 | 10 | 1009.4 | 749.4 | 978.8 | | 985.2 | | 770.0 | | 898.6 | 580.6 | 26.13 | 5.26 | 20.87 |
| 11 | 77 lbs. 13% blood.....N<br>525 lbs. 16% acid phosphate.....3 P<br>50 lbs. 20% manure salt.....K | 10 | 84 | 10 | 1038.8 | 823.0 | 1144.8 | | 1025.0 | | 705.0 | | 947.3 | 714.3 | 32.14 | 6.49 | 25.65 |
| 12 | Unfertilized.....O | | | | 144.6 | 211.2 | 221.2 | | 112.6 | | 50.0 | | 147.9 | | | | |

TABLE III—Continued.

Results in Field B, in 1905, 1907 and 1909.

| Number of Plat | Fertilizer Application Per Acre | Pounds of Nitrogen (N) Per Acre | Pounds of Phosphoric Acid ($P_2O_5$) Per Acre | Pounds of Potash ($K_2O$) Per Acre | Yield of Seed Cotton in Pounds Per Acre | | | | | | | | Average Yield of Seed Cotton in Pounds Per Acre | Average Increase Per Acre Due to Fertilizer | Value of Increase at 4.5 Cents Per Pound | Cost of Fertilizer Per Acre | Average Value of Increase Over Cost of Fertilizer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | 1908 | 1909 | | | | | |
| 5 | Unfertilized—O | | | | | | | 447.4 | | 185.0 | | 160.0 | 264.1 | | $ | $ | $ |
| 9 | 77 lbs. 13% blood—N<br>87.5 lbs. 16% acid phosphate—½ P<br>50 lbs. 20% manure salt—K | 10 | 14 | 10 | | | | 1273.8 | | 750.0 | | 745.0 | 922.9 | 650.5 | 29.27 | 3.42 | 25.85 |
| 5 | Unfertilized—O | | | | | | | 447.4 | | 185.0 | | 160.0 | 264.1 | | | | |
| 4 | 77 lbs. 13% blood—N<br>175 lbs. 16% acid phosphate—P<br>50 lbs. 20% manure salt—K | 10 | 28 | 10 | | | | 1312.0 | | 755.0 | | 710.0 | 925.7 | 661.6 | 29.77 | 4.04 | 25.73 |
| 10 | 77 lbs. 13% blood—N<br>350 lbs. 16% acid phosphate—2 P<br>50 lbs. 20% manure salt—K | 10 | 56 | 10 | | | | 1519.4 | | 865.0 | | 885.0 | 1089.8 | 815.4 | 36.69 | 5.26 | 31.43 |
| 11 | 77 lbs. 13% blood—N<br>525 lbs. 16% acid phosphate—3 P<br>50 lbs. 20% manure salt—K | 10 | 84 | 10 | | | | 1545.6 | | 898.0 | | 810.0 | 1084.5 | 808.0 | 36.36 | 6.49 | 29.87 |
| 14 | Unfertilized—O | | | | | | | 563.2 | | 125.0 | | 160.0 | 282.7 | | | | |

AVERAGE RESULTS FOR EIGHT YEARS ON FIELDS A AND B.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 4–5 | Unfertilized | O | | | | | | | | | |
| 9–9 | 77 lbs. 13% blood | N | 10 | | | | | | | | |
| | 87.5 lbs. 16% acid phosphate | ½ P | | 14 | | 798.1 | 460.4 | 20.72 | 3.42 | 17.30 | |
| | 50 lbs. 20% manure salt | K | | | 10 | | | | | | |
| (4+12)—5 | Unfertilized | O | | | | | | | | | |
| 5–4 | 77 lbs. 13% blood | N | 10 | | | | | | | | |
| | 175 lbs. 16% acid phosphate | P | | 28 | | 1028.3 | 524.6 | 23.61 | 4.04 | 19.57 | |
| | 50 lbs. 20% manure salt | K | | | 10 | | | | | | |
| 10–10 | 77 lbs. 13% blood | N | 10 | | | | | | | | |
| | 350 lbs. 16% acid phosphate | 2 P | | 56 | | 994.2 | 748.0 | 31.41 | 5.26 | 26.15 | |
| | 50 lbs. 20% manure salt | K | | | 10 | | | | | | |
| 11–11 | 77 lbs. 13% blood | N | 10 | | | | | | | | |
| | 525 lbs. 16% acid phosphate | 3 P | | 84 | | 1015.9 | 761.2 | 34.25 | 6.49 | 27.76 | |
| | 50 lbs. 20% manure salt | K | | | 10 | | | | | | |
| 12–14 | Unfertilized | O | | | | | | | | | |

### Effect of Varying Quantities of Phosphoric Acid.

The above experiments (in Table III) were planned to show the effect on the yields of seed cotton of varying quantities of phosphoric acid, the nitrogen and potash remaining the same. On one plat one-half the normal quantity of phosphoric acid was applied, or an amount represented by 87.5 pounds of 16 per cent acid phosphate and equivalent to 3½ per cent phosphoric acid in the fertilizer mixture. On two plats were applied two and three times the normal quantities of phosphoric acid, represented by 350 and 525 pounds of 16 per cent acid phosphate respectively, or 56 and 84 pounds of phosphoric acid per acre. The yields show good profits for all of the fertilizer mixtures. In Field A the largest yield and greatest profit per acre was secured on an average from the plat receiving three times normal (525 pounds of 16 per cent acid phosphate carrying 84 pounds of phosphoric acid) phosphoric acid, while in Field B the plat to which a twice normal (350 pounds of 16 per cent acid phosphate carrying 56 pounds of phosphoric acid) application of phosphoric acid with normal amounts of nitrogen and potash gave a slightly increased yield and profit over the plat receiving three times normal (N $P_3$ K) phosphoric acid. However, as an average of all the tests on both fields there was a slightly greater profit over cost of fertilizer in favor of the heavy (N $P_3$ K) application.

The results on both of the fields, as well as the averages, show that the normal application (175 pounds of 16 per cent acid phosphate carrying 28 pounds of phosphoric acid per acre) is not sufficient phosphoric acid in this soil for most profitable returns per acre with cotton.

By increasing the phosphoric acid application, with normal quantities of nitrogen and potash present, from 14 pounds to 28 pounds per acre each pound of phosphoric acid added yielded a profit of about 16 cents for each pound of the increase, increasing from 28 pounds to 56 pounds per acre each gave a profit of 23.5 cents per pound increase while increasing from 56 to 84 pounds of phosphoric acid per acre only gave an increase of a little less than 5.7 cents per pound for each pound of the 28 pounds of increase in phosphoric acid.

TABLE IV—RESULTS OF FERTILIZER EXPERIMENTS WITH COTTON: EFFECT OF VARYING QUANTITIES OF POTASH ON YIELD.

RESULTS IN FIELD A IN 1902, 1903, 1904, 1906 AND 1908.

| Number of Plat | Fertilizer Application Per Acre | Pounds of Nitrogen (N) Per Acre | Pounds of Phosphoric Acid ($P_2O_5$) Per Acre | Pounds of Potash ($K_2O$) Per Acre | Yield of Seed Cotton in Pounds Per Acre | | | | | | | | Average Yield of Seed Cotton in Pounds Per Acre | Average Increase Per Acre Due to Fertilizer | Value of Increase at 4.5 Cents Per Pound | Cost of Fertilizer Per Acre | Average Value of Increase Over Cost of Fertilizer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | 1908 | 1909 | | | | | |
| 12 | Unfertilized.....O | | | | 144.6 | 211.2 | 221.2 | | 112.6 | | 50.0 | | 147.9 | | $ | $ | $ |
| 13 | 77 lbs. 13% blood.....N<br>175 lbs. 16% acid phosphate.....P<br>25 lbs. 20% manure salt.....½ K | 10 | 28 | 5 | 964.6 | 796.8 | 990.0 | | 850.2 | | 620.0 | | 844.3 | 618.9 | 27.85 | 3.79 | 24.06 |
| 19(1) | Unfertilized.....O | | | | 825.0 | 630.6 | 714.0 | | 251.4 | | 71.3 | | | | | | |
| 4 | Unfertilized.....O | | | | 1229.0 | 903.0 | 970.0 | | 552.6 | | 487.6 | | 828.4 | | | | |
| 5 | 77 lbs. 13% blood.....N<br>175 lbs. 16% acid phosphate.....P<br>50 lbs. 20% manure salt.....K | 10 | 28 | 10 | 1412.0 | 1021.8 | 1230.0 | | 1150.0 | | 840.0 | | 1130.8 | 387.5 | 17.44 | 4.04 | 13.40 |
| 12 | Unfertilized.....O | | | | 144.6 | 211.2 | 221.2 | | 112.6 | | 50.0 | | 147.9 | | | | |
| 12 | Unfertilized.....O | | | | 144.6 | 211.2 | 221.2 | | 112.6 | | 50.0 | | 147.9 | | | | |
| 14 | 77 lbs. 13% blood.....N<br>175 lbs. 16% acid phosphate.....P<br>100 lbs. 20% manure salt.....2 K | 10 | 28 | 20 | 1081.2 | 820.6 | 925.4 | | 907.6 | | 780.0 | | 903.0 | 632.0 | 28.44 | 4.54 | 23.90 |
| 15 | 77 lbs. 13% blood.....N<br>175 lbs. 16% acid phosphate.....P<br>150 lbs. 20% manure salt.....3 K | 10 | 28 | 30 | 1034.4 | 731.2 | 820.4 | | 760.0 | | 710.0 | | 811.2 | 494.8 | 22.27 | 5.04 | 17.23 |
| 19(1) | Unfertilized.....O | | | | 825.0 | 630.6 | 714.0 | | 251.4 | | 71.3 | | | | | | |

TABLE IV—Continued.

Results in Field B in 1905, 1907 and 1909.

| Number of Plat | Fertilizer Application Per Acre | Pounds of Nitrogen (N) Per Acre | Pounds of Phosphoric Acid ($P_2O_5$) Per Acre | Pounds of Potash ($K_2O$) Per Acre | Yield of Seed Cotton in Pounds Per Acre | | | | | | | | Average Yield of Seed Cotton in Pounds Per Acre | Average Increase Per Acre Due to Fertilizer | Value of Increase at 4.5 Cents Per Pound | Cost of Fertilizer Per Acre | Average Value of Increase Over Cost of Fertilizer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | 1908 | 1909 | | | | | |
| 5 | Unfertilized.....O | | | | | | | 447.4 | | 185.0 | | 160.0 | 264.1 | | $ | $ | $ |
| 12 | 77 lbs. 13% blood.....N<br>175 lbs. 16% acid phosphate.....P<br>25 lbs. 20% manure salt.....½ K | 10 | 28 | 5 | | | | 1334.4 | | 695.0 | | 700.0 | 909.8 | 631.2 | 28.40 | 3.79 | 24.61 |
| 5 | Unfertilized.....O | | | | | | | 447.4 | | 185.0 | | 160.0 | 264.1 | | | | |
| 4 | 77 lbs. 13% blood.....N<br>175 lbs. 16% acid phosphate.....P<br>50 lbs. 20% manure salt.....K | 10 | 28 | 10 | | | | 1312.0 | | 755.0 | | 710.0 | 925.7 | 661.6 | 29.77 | 4.04 | 25.73 |
| 13 | 77 lbs. 13% blood.....N<br>175 lbs. 16% acid phosphate.....P<br>100 lbs. 20% manure salt.....2 K | 10 | 28 | 20 | | | | 1452.4 | | 695.0 | | 725.0 | 957.5 | 676.8 | 30.46 | 4.54 | 25.92 |
| 14 | Unfertilized.....O | | | | | | | 563.2 | | 125.0 | | 160.0 | 282.7 | | | | |
| 15 | 77 lbs. 13% blood.....N<br>175 lbs. 16% acid phosphate.....P<br>150 lbs. 20% manure salt.....3 K | 10 | 28 | 30 | | | | 1330.0 | | 710.0 | | 655.0 | 898.3 | 615.6 | 27.70 | 5.04 | 22.66 |
| 14 | Unfertilized.....O | | | | | | | 563.2 | | 125.0 | | 160.0 | 282.7 | | | | |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12–5 | Unfertilized | O | | | | | | | | | | | | | | | | |
| 13–12 | 77 lbs. 13% blood | N | 10 | | | | | | | | | | | | 877.1 | 625.1 | 28.13 | 3.79 | 24.34 |
| | 175 lbs. 16% acid phosphate | P | | 28 | | | | | | | | | | | | | | | |
| | 25 lbs. 20% manure salt | ½ K | | | 5 | | | | | | | | | | | | | | |
| (4+12)—5 | Unfertilized | O | | | | | | | | | | | | | | | | | |
| 5–4 | 77 lbs. 13% blood | N | 10 | | | | | | | | | | | | 1028.3 | 524.6 | 23.61 | 4.04 | 19.57 |
| | 175 lbs. 16% acid phosphate | P | | 28 | | | | | | | | | | | | | | | |
| | 50 lbs. 20% manure salt | K | | | 10 | | | | | | | | | | | | | | |
| 14–13 | 77 lbs. 13% blood | N | 10 | | | | | | | | | | | | 930.3 | 654.4 | 29.45 | 4.54 | 24.91 |
| | 175 lbs. 16% acid phosphate | P | | 28 | | | | | | | | | | | | | | | |
| | 100 lbs. 20% manure salt | 2 K | | | 20 | | | | | | | | | | | | | | |
| (12+19)—14 | Unfertilized | O | | | | | | | | | | | | | | | | | |
| 15–15 | 77 lbs. 13% blood | N | 10 | | | | | | | | | | | | 854.8 | 555.2 | 24.99 | 5.04 | 19.95 |
| | 175 lbs. 16% acid phosphate | P | | 28 | | | | | | | | | | | | | | | |
| | 150 lbs. 20% manure salt | 3 K | | | 30 | | | | | | | | | | | | | | |
| 19–14 | Unfertilized | O | | | | | | | | | | | | | | | | | |

(1)In 1906 and in 1908 for Field A, the effects of the different fertilizer treatments to plats 13, 14 and 15 were determined by subtracting from each of them the average of the yields secured on unfertilized plats 12 and 13², instead of by the method used on these plats for the years 1902, 1903 and 1904.

### Effect of Varying Quantities of Potash.

The experiments reported in Table IV were arranged to show the effect on the yield of seed cotton of varying quantities of potash, the nitrogen and phosphoric acid remaining constant. On one plat only one-half the normal quantity of potash was applied, or 1¼ per cent in the fertilizer mixture, or 5 pounds of potash per acre, while on two other plats two and three times the normal quantities were given, or 20 and 30 pounds of actual potash per acre respectively. On basis of the normal fertilizer mixture this would represent 5 and 7½ per cent of potash in the mixture.

The results are not uniform for the two fields, the most profitable application being slightly in favor of 5 pounds of potash per acre for Field A and slightly in favor of the use of 20 pounds of potash in Field B. The largest average increase in yield of seed cotton as well as the greatest profit per acre, was obtained from the plats receiving 20 pounds of potash (100 pounds of manure salt) per acre with the regular quantities of nitrogen and phosphoric acid employed in the mixtures.

TABLE V—RESULTS OF FERTILIZER EXPERIMENTS WITH COTTON: EFFECT OF VARYING QUANTITIES OF FERTILIZER ON YIELD.

RESULTS IN FIELD A IN 1902, 1903, 1904, 1906 AND 1908.

| Number of Plat | Fertilizer Application Per Acre | Pounds of Nitrogen (N) Per Acre | Pounds of Phosphoric Acid ($P_2O_5$) Per Acre | Pounds of Potash ($K_2O$) Per Acre | Yield of Seed Cotton in Pounds Per Acre | | | | | | | | Average Yield of Seed Cotton in Pounds Per Acre | Average Increase Per Acre Due to Fertilizer | Value of Increase at 4.5 Cents Per Pound | Cost of Fertilizer Per Acre | Average Value of Increase Over Cost of Fertilizer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | 1908 | 1909 | | | | | |
| 12 | Unfertilized—O | | | | 144.6 | 211.2 | 221.2 | | 112.6 | | 50.0 | | 147.9 | | $ | $ | $ |
| 16 | 38.5 lbs. 13% blood—½ N<br>87.5 lbs. 16% acid phosphate—½ P<br>25 lbs. 20% manure salt—½ K | 5 | 14 | 5 | 850.6 | 645.6 | 734.6 | | 695.0 | | 605.0 | | 706.2 | 344.2 | 15.49 | 2.02 | 13.47 |
| 19(1) | Unfertilized—O | | | | 825.0 | 630.6 | 714.0 | | 251.4 | | 71.3 | | | | | | |
| 4 | Unfertilized—O | | | | 1229.0 | 903.0 | 970.0 | | 552.6 | | 487.6 | | 828.4 | | | | |
| 5 | 77 lbs. 13% blood—N<br>175 lbs. 16% acid phosphate—P<br>50 lbs. 20% manure salt—K | 10 | 28 | 10 | 1412.0 | 1021.8 | 1230.0 | | 1150.0 | | 840.0 | | 1130.8 | 387.5 | 17.44 | 4.04 | 13.40 |
| 12 | Unfertilized—O | | | | 144.6 | 211.2 | 221.2 | | 112.6 | | 50.0 | | 147.9 | | | | |
| 1[2] | 115.5 lbs. 13% blood—1½ N<br>262.5 lbs. 16% acid phosphate—1½ P<br>75 lbs. 20% manure salt—1½ K | 15 | 42 | 15 | 1293.6 | 955.6 | 1177.4 | | 1292.6 | | 1095.0 | | 1162.8 | 557.8 | 25.10 | 6.05 | 19.05 |
| 2[2] | 154 lbs. 13% blood—2 N<br>350 lbs. 16% acid phosphate—2 P<br>100 lbs. 20% manure salt—2 K | 20 | 56 | 20 | 1436.8 | 1178.2 | 1298.0 | | 1052.6 | | 1110.0 | | 1215.1 | 610.1 | 27.45 | 8.07 | 19.38 |
| 3[2] | 231 lbs. 13% blood—3 N<br>535 lbs. 16% acid phosphate—3 P<br>150 lbs. 20% manure salt—3 K | 30 | 84 | 30 | 1541.0 | 1158.2 | 1391.2 | | 1375.2 | | 1210.0 | | 1335.1 | 730.1 | 32.85 | 12.11 | 20.74 |
| 5[2] | Unfertilized—O | | | | 859.6 | 668.2 | 666.8 | | 512.6 | | 317.6 | | 605.0 | | | | |

TABLE V—Continued.

Results in Field B in 1905, 1907 and 1909.

| Number of Plat | Fertilizer Application Per Acre | Pounds of Nitrogen (N) Per Acre | Pounds of Phosphoric Acid ($P_2O_5$) Per Acre | Pounds of Potash ($K_2O$) Per Acre | Yield of Seed Cotton in Pounds Per Acre | | | | | | | | Average Yield of Seed Cotton in Pounds Per Acre | Average Increase Per Acre Due to Fertilizer | Value of Increase at 4.5 Cents Per Pound | Cost of Fertilizer Per Acre | Average Value of Increase Over Cost of Fertilizer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | 1908 | 1909 | | | | | |
| 14 | Unfertilized.....O | | | | | | | 563.2 | | 125.0 | | 160.0 | 282.7 | | $ | $ | $ |
| 16 | 38.5 lbs. 13% blood.....½ N | 5 | | | | | | 1073.2 | | 515.0 | | 645.0 | 744.4 | 461.7 | 20.78 | 2.02 | 18.76 |
| | 87.5 lbs. 16% acid phosphate..½ P | | 14 | | | | | | | | | | | | | | |
| | 25 lbs. 20% manure salt.....½ K | | | 5 | | | | | | | | | | | | | |
| 4 | 77 lbs. 13% blood.....N | 10 | | | | | | 1312.0 | | 755.0 | | 710.0 | 925.7 | 661.6 | 29.77 | 4.04 | 25.73 |
| | 175 lbs. 16% acid phosphate..P | | 28 | | | | | | | | | | | | | | |
| | 50 lbs. 20% manure salt.....K | | | 10 | | | | | | | | | | | | | |
| 5 | Unfertilized.....O | | | | | | | 447.4 | | 185.0 | | 160.0 | 264.1 | | | | |
| 14 | Unfertilized.....O | | | | | | | 563.2 | | 125.0 | | 160.0 | 282.7 | | | | |
| 17 | 115.5 lbs. 13% blood.....1½ N | 15 | | | | | | 1630.8 | | 750.0 | | 1000.0 | 1126.9 | 844.2 | 37.99 | 6.05 | 31.94 |
| | 262.5 lbs. 16% acid phosphate..1½ P | | 42 | | | | | | | | | | | | | | |
| | 75 lbs. 20% manure salt.....1½ K | | | 15 | | | | | | | | | | | | | |
| 1[2] | 154 lbs. 13% blood.....2 N | 20 | | | | | | 1267.0 | | 810.0 | | 900.0 | 992.3 | 726.7 | 32.70 | 8.07 | 24.63 |
| | 350 lbs. 16% acid phosphate..2 P | | 56 | | | | | | | | | | | | | | |
| | 100 lbs. 20% manure salt.....2 K | | | 20 | | | | | | | | | | | | | |
| 2[2] | 231 lbs. 13% blood.....3 N | 30 | | | | | | 1549.2 | | 715.0 | | 895.0 | 1053.1 | 787.8 | 35.45 | 12.11 | 23.34 |
| | 525 lbs. 16% acid phosphate..3 P | | 84 | | | | | | | | | | | | | | |
| | 150 lbs. 20% manure salt.....3 K | | | 30 | | | | | | | | | | | | | |
| 4[2] | Unfertilized.....O | | | | | | | 431.8 | | 200.0 | | 165.0 | 265.6 | | | | |

AVERAGE RESULTS FOR EIGHT YEARS ON FIELDS A AND B.

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (12+19)—14 | Unfertilized | O | | | | | | | | | | | | | | |
| 16-16 | 38.5 lbs. 13% blood | ½ N | 5 | | | | | | | | | | | 725.3 | 403.0 | 18.14 | 2.02 | 16.12 |
| | 87.5 lbs. 16% acid phosphate | ½ P | | 14 | | | | | | | | | | | | | | |
| | 25 lbs. 20% manure salt | ½ K | | | 5 | | | | | | | | | | | | | |
| (4+12)—5 | Unfertilized | O | | | | | | | | | | | | | | | | |
| 5-4 | 77 lbs. 13% blood | N | 10 | | | | | | | | | | | 1028.3 | 524.6 | 23.61 | 4.04 | 19.57 |
| | 175 lbs. 16% acid phosphate | P | | 28 | | | | | | | | | | | | | | |
| | 50 lbs. 20% manure salt | K | | | 10 | | | | | | | | | | | | | |
| $5^2$—14 | Unfertilized | O | | | | | | | | | | | | | | | | |
| $1^2$—17 | 115.5 lbs. 13% blood | 1½ N | 15 | | | | | | | | | | | 1144.9 | 701.0 | 31.55 | 6.05 | 25.50 |
| | 262.5 lbs. 16% acid phosphate | 1½ P | | 42 | | | | | | | | | | | | | | |
| | 75 lbs. 20% manure salt | 1½ K | | | 15 | | | | | | | | | | | | | |
| $2^2$—$1^2$ | 154 lbs. 13% blood | 2 N | 20 | | | | | | | | | | | 1103.7 | 668.4 | 30.08 | 8.07 | 22.01 |
| | 350 lbs. 16% acid phosphate | 2 P | | 56 | | | | | | | | | | | | | | |
| | 100 lbs. 20% manure salt | 2 K | | | 20 | | | | | | | | | | | | | |
| $3^2$—$2^2$ | 231 lbs. 13% blood | 3 N | 30 | | | | | | | | | | | 1194.1 | 759.0 | 34.15 | 12.11 | 22.04 |
| | 525 lbs. 16% acid phosphate | 3 P | | 84 | | | | | | | | | | | | | | |
| | 150 lbs. 20% manure salt | 3 K | | | 30 | | | | | | | | | | | | | |
| $5^2$—$4^2$ | Unfertilized | O | | | | | | | | | | | | | | | | |

(1)In 1906 and in 1908 for Field A, the effects of the different fertilizer treatments to plat 16 was determined by subtracting from it the average of the yields secured on unfertilized plats 12 and $13^2$, instead of by the method used on this plat for the years 1902, 1903 and 1904.

### Effect of Varying Quantities of Fertilizer on Yields.

The experiments, results of which are given in Table V, were planned to show the effect of increasing and decreasing the normal (N P K equals 400 pounds of a fertilizer mixture containing 7 per cent phosphoric acid, 2½ per cent potash and 2½ per cent nitrogen) fertilizer application on the yields of cotton. The applications were at the rate of 200 pounds per acre (½ N P K); 400 pounds per acre (N P K); 600 pounds per acre (1½ N P K); 800 pounds per acre (2 N P K); 1,200 pounds per acre (3 N P K). The results on the two fields and the averages of these fields are quite uniform in showing increased yields and increased profits for the several increases in the amounts of fertilizer up to 600 pounds per acre. On an average of the results of the tests on both fields the use of 800 and 1,200 pounds of the fertilizer mixture per acre gave a greater increase in value of total crop (lint and seed) over cost of fertilizer than did the use of 200 or 400 pounds per acre of the same mixture.

In addition to larger profits from heavier fertilization of the right kind, the land is in all probability improving in productiveness and value. Results on these plats and fields in after years will be most valuable in throwing light on this most important phase of the proper fertilization for immediate returns and for the permanent improvement of the soil. This latter phase of farm practice is not given the thought and consideration it should receive by most farmers.

TABLE VI—RESULTS OF FERTILIZER EXPERIMENTS WITH COTTON: EFFECT OF DIFFERENT MATERIALS [SUPPLYING NITROGEN] AND TIME OF APPLICATION.

RESULTS IN FIELD A IN 1902, 1903, 1904, 1906, AND 1908.

| Number of Plat | Fertilizer Application Per Acre | Pounds of Nitrogen (N) Per Acre | Pounds of Phosphoric Acid ($P_2O_5$) Per Acre | Pounds of Potash ($K_2O$) Per Acre | Yield of Seed Cotton in Pounds Per Acre | | | | | | | | Average Yield of Seed Cotton in Pounds Per Acre | Average Increase Per Acre Due to Fertilizer | Value of Increase at 4.5 Cents Per Pound | Cost of Fertilizer Per Acre | Average Value of Increase Over Cost of Fertilizer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | 1908 | 1909 | | | | | |
| 5[2] | Unfertilized—O | | | | 859.6 | 668.2 | 666.8 | | 512.6 | | 317.6 | | 605.0 | | $ | $ | $ |
| *4[2] | 38.5 lbs. 13% blood—½ N<br>33.8 lbs. 14.8% nitrate of soda—½ N<br>175 lbs. 16% acid phosphate—P<br>50 lbs. 20% manure salt—K | 5<br>5 | <br><br>28<br> | <br><br><br>10 | 1208.4 | 957.6 | 1076.8 | | 1110.2 | | 830.0 | | 1036.6 | 431.6 | 19.42 | 3.73 | 15.69 |
| 5[2] | Unfertilized—O | | | | 859.6 | 668.2 | 666.8 | | 512.6 | | 317.6 | | 605.0 | | | | |
| †6[2] | 67.6 lbs. 14.8% nitrate of soda—N<br>175 lbs. 16% acid phosphate—P<br>50 lbs. 20% manure salt—K | 10<br> | <br>28<br> | <br><br>10 | 1318.8 | 1057.6 | 1197.0 | | 867.6 | | 905.0 | | 1069.2 | 468.0 | 21.06 | 3.42 | 17.64 |
| ‡7[2] | 77 lbs. 13% blood—N<br>175 lbs. 16% acid phosphate—P<br>50 lbs. 20% manure salt—K | 10<br> | <br>28<br> | <br><br>10 | 1246.2 | 971.2 | 1121.6 | | 1120.2 | | 790.0 | | 1049.8 | 452.5 | 20.36 | 4.04 | 16.32 |
| ¶8[2] | 61.6 lbs. 13% blood—4/5 N<br>13.5 lbs. 14.8% nitrate of soda—1/5 N<br>175 lbs. 16% acid phosphate—P<br>50 lbs. 20% manure salt—K | 8<br>2<br> | <br><br>28<br> | <br><br><br>10 | 1344.0 | 1021.2 | 1098.4 | | 1145.0 | | 860.0 | | 1093.7 | 500.2 | 22.51 | 3.91 | 18.60 |
| (1)9[2] | 322.6 lbs. cotton seed—N<br>148.9 lbs. 16% acid phosphate—P<br>30.6 lbs. 20% manure salt—K | 10<br> | 4.2<br>23.8<br> | 3.9<br><br>6.1 | 1224.0 | 910.0 | 986.6 | | 965.0 | | 715.0 | | 960.1 | 370.5 | 16.67 | 5.22 | 11.45 |
| (2)10[2] | 2000 stable manure—N<br>150 lbs. 16% acid phosphate—P<br>20 lbs. 20% manure salt—K | 10<br> | 4<br>24<br> | 6<br><br>4 | 1341.8 | 1000.6 | 1049.4 | | 1222.6 | | 865.0 | | 1095.9 | 510.1 | 22.95 | 3.25 | 19.70 |
| 13[2] | Unfertilized—O | | | | 910.6 | 775.0 | 703.2 | | 390.2 | | 92.6 | | 574.3 | | | | |

TABLE VI—Continued.

Results in Field A in 1902, 1903, 1904, 1906 and 1908—Continued.

| Number of Plat | Fertilizer Application Per Acre | Pounds of Nitrogen (N) Per Acre | Pounds of Phosphoric Acid ($P_2O_5$) Per Acre | Pounds of Potash ($K_2O$) Per Acre | Yield of Seed Cotton in Pounds Per Acre | | | | | | | | Average Yield of Seed Cotton in Pounds Per Acre | Average Increase Per Acre Due to Fertilizer | Value of Increase at 4.5 Cents Per Pound | Cost of Fertilizer Per Acre | Average Value of Increase Over Cost of Fertilizer. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | 1908 | 1909 | | | | | |
| 4 | Unfertilized—O | | | | 1229.0 | 903.0 | 970.0 | | 552.6 | | 487.6 | | 828.4 | | $ | $ | $ |
| (3)5 | 77 lbs. 13% blood—N | 10 | | | 1412.0 | 1021.8 | 1230.0 | | 1150.0 | | 840.0 | | 1130.8 | 387.5 | 17.44 | 4.04 | 13.40 |
| | 175 lbs. 16% acid phosphate—P | | 28 | | | | | | | | | | | | | | |
| | 50 lbs. 20% manure salt—K | | | 10 | | | | | | | | | | | | | |
| 12 | Unfertilized—O | | | | 144.6 | 211.2 | 221.2 | | 112.6 | | 50.0 | | 147.9 | | | | |

Results in Field B in 1905, 1907, and 1909.

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4[2] | Unfertilized—O | | | | | | | 431.8 | | 200.0 | | 165.0 | 265.6 | | | | |
| *3[2] | 38.5 lbs. 13% blood—½ N | 5 | | | | | | | | | | | | | | | |
| | 33.8 lbs. 14.8% nitrate of soda—½ N | 5 | | | | | | 1222.6 | | 615.0 | | 725.0 | 854.2 | 588.6 | 26.49 | 3.73 | 22.76 |
| | 175 lbs. 16% acid phosphate—P | | 28 | | | | | | | | | | | | | | |
| | 50 lbs. 20% manure salt—K | | | 10 | | | | | | | | | | | | | |
| 4[2] | Unfertilized—O | | | | | | | 431.8 | | 200.0 | | 165.0 | 265.6 | | | | |
| †5[2] | 67.6 lbs. 14.8% nitrate of soda—N | 10 | | | | | | 1259.0 | | 735.0 | | 675.0 | 889.7 | 619.5 | 27.88 | 3.42 | 24.46 |
| | 175 lbs. 16% acid phosphate—P | | 28 | | | | | | | | | | | | | | |
| | 50 lbs. 20% manure salt—K | | | 10 | | | | | | | | | | | | | |
| ‡6[2] | 77 lbs. 13% blood—N | 10 | | | | | | 1186.4 | | 710.0 | | 660.0 | 852.1 | 577.3 | 25.98 | 4.04 | 21.94 |
| | 175 lbs. 16% acid phosphate—P | | 28 | | | | | | | | | | | | | | |
| | 50 lbs. 20% manure salt—K | | | 10 | | | | | | | | | | | | | |
| ¶7[2] | 61.6 lbs. 13% blood—4/5 N | 8 | | | | | | 1309.2 | | 850.0 | | 735.0 | 964.7 | 685.3 | 30.84 | 3.91 | 26.93 |
| | 13.5 lbs. 14.8% nitrate of soda—1/5 N | 2 | | | | | | | | | | | | | | | |
| | 175 lbs. 16% acid phosphate—P | | 28 | | | | | | | | | | | | | | |
| | 50 lbs. 20% manure salt—K | | | 10 | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1)8² | 322.6 lbs. cotton seed—N | 10 | 4.2 | 3.9 | 1053.2 | 680.0 | 600.0 | 777.7 | 493.7 | 22.22 | 5.22 | 17.00 |
| | 148.9 lbs. 16% acid phosphate—P | | 23.8 | | | | | | | | | |
| | 30.6 lbs. 20% manure salt—K | | | 6.1 | | | | | | | | |
| (2)9² | 2000 lbs. stable manure—N | 10 | 4 | 6 | 1222.0 | 770.0 | 675.0 | 889.0 | 600.5 | 27.02 | 3.25 | 23.77 |
| | 150 lbs. 16% acid phosphate—P | | 24 | | | | | | | | | |
| | 20 lbs. 20% manure salt—K | | | 4 | | | | | | | | |
| 14² | Unfertilized—O | | | | 534.4 | 180.0 | 220.0 | 311.5 | | | | |
| 5 | Unfertilized—O | | | | 447.4 | 185.0 | 160.0 | 264.1 | | | | |
| (3)4 | 77 lbs. 13% blood—N | 10 | | | 1312.0 | 755.0 | 710.0 | 925.7 | 661.6 | 29.77 | 4.04 | 25.73 |
| | 175 lbs. 16% acid phosphate—P | | 28 | | | | | | | | | |
| | 50 lbs. 20% manure salt—K | | | 10 | | | | | | | | |

AVERAGE RESULTS FOR EIGHT YEARS ON FIELDS A AND B.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5²–4² | Unfertilized—O | | | | | | | | | | | | | |
| *4²–3² | 38.5 lbs. 13% blood—½ N | 5 | | | | | | | | | | | | |
| | 33.8 lbs. 14.8% nitrate of soda—½ N | 5 | | | | | | | | | | 945.4 | 510.1 | 21.96 | 3.73 | 19.23 |
| | 175 lbs. 16% acid phosphate—P | | 28 | | | | | | | | | | | |
| | 50 lbs. 20% manure salt—K | | | 10 | | | | | | | | | | |
| 5²–4² | Unfertilized—O | | | | | | | | | | | | | |
| †6²–5² | 67.6 lbs. 14.8% nitrate of soda—N | 10 | | | | | | | | | | 979.5 | 543.8 | 24.47 | 3.42 | 21.05 |
| | 175 lbs. 16% acid phosphate—P | | 28 | | | | | | | | | | | |
| | 50 lbs. 20% manure salt—K | | | 10 | | | | | | | | | | |
| ‡7²–6² | 77 lbs. 13% blood—N | 10 | | | | | | | | | | 951.0 | 514.9 | 23.17 | 4.04 | 19.13 |
| | 175 lbs. 16% acid phosphate—P | | 28 | | | | | | | | | | | |
| | 50 lbs. 20% manure salt—K | | | 10 | | | | | | | | | | |
| ¶8²–7² | 61.6 lbs. 13% blood—4/5 N | 8 | | | | | | | | | | 1029.2 | 592.8 | 26.68 | 3.91 | 22.77 |
| | 13.5 lbs. 14.8% nitrate of soda—1/5 N | 2 | | | | | | | | | | | | |
| | 175 lbs. 16% acid phosphate—P | | 28 | | | | | | | | | | | |
| | 50 lbs. 20% manure salt—K | | | 10 | | | | | | | | | | |

TABLE VI—Continued.

| Number of Plat | Fertilizer Application Per Acre | Pounds of Nitrogen (N) Per Acre | Pounds of Phosphoric Acid ($P_2O_5$) Per Acre | Pounds of Potash ($K_2O$) Per Acre | Yield of Seed Cotton in Pounds Per Acre | | | | | | | | Average Yield of Seed Cotton in Pounds Per Acre | Average Increase Per Acre Due to Fertilizer | Value of Increase at 4.5 Cents Per Pound | Cost of Fertilizer Per Acre | Average Value of Increase Over Cost of Fertilizer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | 1908 | 1909 | | | | | |
| (1)9²–8² | 322.6 lbs. cotton seed—N | 10 | 4.2 | 3.9 | | | | | | | | | | | | | |
| | 148.9 lbs. 16% acid phosphate—P | | 23.8 | | | | | | | | | | 868.9 | 432.1 | $ 19.45 | $ 5.22 | $ 14.23 |
| | 30.6 lbs. 20% manure salt—K | | | 6.1 | | | | | | | | | | | | | |
| (2)10²–9² | 2000 lbs. stable manure—N | 10 | 4 | 6 | | | | | | | | | | | | | |
| | 150 lbs. 16% acid phosphate—P | | 24 | | | | | | | | | | 992.5 | 555.3 | 24.99 | 3.25 | 21.74 |
| | 20 lbs. 20% manure salt—K | | | 4 | | | | | | | | | | | | | |
| 13²–14² | Unfertilized—O | | | | | | | | | | | | | | | | |
| (4+12)—5 | Unfertilized—O | | | | | | | | | | | | | | | | |
| (3)5–4 | 77 lbs. 13% blood—N | 10 | | | | | | | | | | | | | | | |
| | 175 lbs. 16% acid phosphate—P | | 28 | | | | | | | | | | 1028.3 | 524.6 | 23.61 | 4.04 | 19.57 |
| | 50 lbs. 20% manure salt—K | | | 10 | | | | | | | | | | | | | |

*Two applications of nitrogen: one-half as blood applied with the phosphatic and potassic materials in drill at planting and the other one-half as nitrate of soda about July 1. In 1902 and 1903 cottonseed meal was used instead of blood and kainit instead of manure salt on all the plats of Field A to supply nitrogen and potash.

†Two applications of nitrogen: One-half as nitrate of soda with other materials in drill at planting; and one-half as nitrate of soda about July 1.

‡Two applications of nitrogen: One-half as blood with other materials in drill at planting; and one-half as blood about July 1.

¶Two sources of nitrogen: One-fifth as nitrate of soda and four-fifths as blood, all applied with other materials in drill at planting.

(1)All nitrogen supplied by cotton seed and applied with other materials in drill at planting. Part of the phosphoric acid and potash as indicated is derived from the cotton seed.

(2)All nitrogen supplied by stable manure and applied with other materials in drill at planting. Part of the phosphoric acid and potash as indicated is derived from the manure.

(3)All nitrogen supplied by blood and applied with other materials in drill at planting.

## EFFECT OF DIFFERENT MATERIALS FURNISHING NITROGEN AND TIME OF APPLICATION.

The experiments, the results of which are presented in Table VI, were arranged to test the comparative value of dried blood, nitrate of soda, cotton seed, and stable manure as nitrogen-furnishing materials in growing cotton, as well as the best way of applying the blood and nitrate of soda.

Nitrate of soda is a material easily soluble in water and therefore quickly available for the use of plants. The questions usually raised in connection with its use are the possibility of its loss from the soil, especially those of a sandy or open, porous nature, because of its easy solubility in water, and its giving out before a long-seasoned crop has made its growth, thus leaving it without a supply of nitrogen before the end of the growing season. Its use is most strongly advocated for short-season crops, as in early truck and vegetable growing and as a top dresser for grain and for corn and cotton after growth is well advanced, or for any crop when it is seen to be in need of a quickly-acting nitrogen supplying material.

Dried blood, which is a fair representative of the animal and vegetable materials furnishing nitrogen, as cotton-seed meal, tankage, etc., is not soluble in water and acts more slowly and for a longer time. It must be changed by rotting or decomposing in the soil into nitrate before it can feed the crop, and is thus likely to be effective throughout a reasonable growing season. The cotton seed and stable manure as they ordinarily rot very slowly are much slower in their fertilizing action than are materials like dried blood and cotton-seed meal.

It has become a practice in growing many crops to apply only a part of the nitrogen in some organic form at the time of planting and a portion later, usually as nitrate of soda, so as to keep the crop growing as rapidly as possible. The tests in Table VI were planned with a view of throwing as much light as possible on these questions of nitrogen fertilization. In the experiments all of the phosphoric acid and potash were applied in the drill before planting. On plats $4^2$ and $3^2$ one-half the nitrogen was supplied as dried blood and was applied with the phosphoric acid and potash before planting, and one-half the nitrogen was supplied as nitrate of soda and applied about July 1. In plats $6^2$ and $5^2$ all of the nitrogen was furnished by nitrate of soda, one-half being applied before planting, with the phosphoric acid and potash and the other half about July 1. On plats $7^2$ and $6^2$ the nitrogen was supplied by dried blood, one-half being applied before planting, with the phosphoric acid and potash and the other half about July 1. On plats $8^2$ and $7^2$ four-fifths of the nitrogen was furnished by dried blood and one-fifth by nitrate of soda and was all applied before planting, along with the phosphoric acid and potash.

Cotton seed, applied at planting or just before, supplied all the nitrogen to plats $9^2$ and $8^2$, while stable manure furnished all the nitrogen applied to plats $10^2$ and $9^2$. Dried blood applied in the drill at planting with normal quantities of phosphoric acid and potash provided all the nitrogen applied to plat 5 of Field A and plat 4 of Field B.

While there were variations in the different years and on the two fields from the nitrogen-supplying materials and methods of application, the

average results for the eight years show rather marked uniformity in the relative yields on the different plats of the two fields receiving different treatments or the same kind and quantity of fertilizer per acre but applied in a different manner. The average results of the different treatments of the plats in the two fields are not greatly different except in the case of those secured from the plats to which cotton seed were used to supply all the nitrogen. On an average, where cotton seed were used to supply the nitrogen, the profit above cost of fertilizer was from $4.90 to $8.52 less per acre than from the other carriers used in the way indicated.

It might be stated, as will be seen from the average results contained in Table VI, that slightly the largest average profit was obtained from applying all of the nitrogen along with the phosphoric acid and potash before planting, having four-fifths of it supplied as dried blood and one-fifth as nitrate of soda. The additional expense of dividing the application of nitrogen and applying one-half before planting and one-half later does not seem justified by the results of the experiments. It is to be borne in mind that the soil on which these tests were made is a sandy clay loam with a good clay subsoil, and the danger of loss from leaching is very slight, if any. It is quite clear from the eight years' work on this soil with an application of 400 pounds per acre that the most economical way of applying the fertilizer is to put it all in the drill before planting the crop, however the results might be different on sandy loams or sandy soil. Where stable manure is used in quantities above one or two tons per acre, it will generally be best to apply it broadcast.

TABLE VII—RESULTS OF FERTILIZER EXPERIMENTS WITH COTTON: EFFECT OF DIFFERENT METHODS AND TIME OF APPLICATION.

RESULTS IN FIELD A IN 1902, 1903, 1904, 1906 AND 1908.

| Number of Plat | Fertilizer Application Per Acre | Pounds of Nitrogen (N) Per Acre | Pounds of Phosphoric Acid ($P_2O_5$) Per Acre | Pounds of Potash ($K_2O$) Per Acre | Yield of Seed Cotton in Pounds Per Acre | | | | | | | | Average Yield of Seed Cotton in Pounds Per Acre | Average Increase Per Acre Due to Fertilizer | Value of Increase at 4.5 Cents Per Pound | Cost of Fertilizer Per Acre | Average Value of Increase Over Cost of Fertilizer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | 1908 | 1909 | | | | | |
| 4 | Unfertilized O | | | | 1229.0 | 903.0 | 970.0 | | 552.6 | | 487.6 | | 828.4 | | $ | $ | $ |
| *5 | 77 lbs. 13% blood N<br>175 lbs. 16% acid phosphate P<br>50 lbs. 20% manure salt K | 10 | 28 | 10 | 1412.0 | 1021.8 | 1230.0 | | 1150.0 | | 840.0 | | 1130.8 | 387.5 | 17.44 | 4.04 | 13.40 |
| 12 | Unfertilized O | | | | 144.6 | 211.2 | 221.2 | | 112.6 | | 50.0 | | 147.9 | | | | |
| 5[2] | Unfertilized O | | | | 859.6 | 668.2 | 666.8 | | 512.6 | | 317.6 | | 605.0 | | | | |
| †11[2] | 77 lbs. 13% blood N<br>175 lbs. 16% acid phosphate P<br>50 lbs. 20% manure salt K | 10 | 28 | 10 | 1348.0 | 1024.2 | 995.6 | | 1102.6 | | 755.0 | | 1045.1 | 463.1 | 20.84 | 4.04 | 16.80 |
| 13[2] | Unfertilized O | | | | 910.6 | 775.0 | 703.2 | | 390.2 | | 92.6 | | 574.3 | | | | |
| 13[2] | Unfertilized O | | | | 910.6 | 775.0 | 703.2 | | 390.2 | | 92.6 | | 574.3 | | | | |
| ‡15[2] | 77 lbs. 13% blood N<br>175 lbs. 16% acid phosphate P<br>50 lbs. 20% manure salt K | 10 | 28 | 10 | 1084.4 | 854.0 | 806.2 | | 810.2 | | 576.6 | | 826.3 | 331.2 | 14.90 | 4.04 | 10.86 |
| ¶16[2] | 77 lbs. 13% blood N<br>175 lbs. 16% acid phosphate P<br>50 lbs. 20% manure salt K | 10 | 28 | 10 | 1014.4 | 850.6 | 915.8 | | 932.6 | | 810.0 | | 904.7 | 449.2 | 20.21 | 4.04 | 16.17 |
| 19[2](2) | Unfertilized O | | | | 383.8 | 374.4 | 442.6 | | | | | | | | | | |

TABLE VII—Continued.

Results in Field B in 1905, 1907 and 1909.

| Number of Plat | Fertilizer Application Per acre | Pounds of Nitrogen (N) Per Acre | Pounds of Phosphoric Acid ($P_2O_5$) Per Acre | Pounds of Potash ($K_2O$) Per Acre | Yield of Seed Cotton in Pounds Per Acre | | | | | | | | Average Yield of Seed Cotton in Pounds Per Acre | Average Increase Per Acre Due to Fertilizer | Value of Increase at 4.5 Cents Per Pound | Cost of Fertilizer Per Acre | Average Value of Increase Over Cost of Fertilizer. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | 1908 | 1909 | | | | | |
| 5 | Unfertilized.....O | | | | | | | 447.4 | | 185.0 | | 160.0 | 264.1 | | $ | $ | $ |
| *4 | 77 lbs. 13% blood.....N | 10 | | | | | | | | | | | | | | | |
| | 175 lbs. 16% acid phosphate.....P | | 28 | | | | | 1312.0 | | 755.0 | | 710.0 | 925.7 | 661.6 | 29.77 | 4.04 | 25.73 |
| | 50 lbs. 20% manure salt.....K | | | 10 | | | | | | | | | | | | | |
| 4[2] | Unfertilized.....O | | | | | | | 431.8 | | 200.0 | | 165.0 | 265.6 | | | | |
| †10[2] | 77 lbs. 13% blood.....N | 10 | | | | | | | | | | | | | | | |
| | 175 lbs. 16% acid phosphate.....P | | 28 | | | | | 1053.6 | | 655.0 | | 645.0 | 784.5 | 491.4 | 22.11 | 4.04 | 18.07 |
| | 50 lbs. 20% manure salt.....K | | | 10 | | | | | | | | | | | | | |
| ‡13[2] | 77 lbs. 13% blood.....N | 10 | | | | | | | | | | | | | | | |
| | 175 lbs. 16% acid phosphate.....P | | 28 | | | | | 1298.8 | | 705.0 | | 715.0 | 906.3 | 599.4 | 26.97 | 4.04 | 22.93 |
| | 50 lbs. 20% manure salt.....K | | | 10 | | | | | | | | | | | | | |
| 14[2] | Unfertilized.....O | | | | | | | 534.4 | | 180.0 | | 220.0 | 311.5 | | | | |
| 14[2] | Unfertilized.....O | | | | | | | 534.4 | | 180.0 | | 220.0 | 311.5 | | | | |
| ¶15[2] | 77 lbs. 13% blood.....N | 10 | | | | | | | | | | | | | | | |
| | 175 lbs. 16% acid phosphate.....P | | 28 | | | | | 1314.4 | | 710.0 | | 790.0 | 938.1 | 616.2 | 27.73 | 4.04 | 23.69 |
| | 50 lbs. 20% manure salt.....K | | | 10 | | | | | | | | | | | | | |
| (1)23[2] | Unfertilized.....O | | | | | | | 411.2 | | 180.0 | | 625.0 | 405.4 | | | | |

AVERAGE RESULTS FOR EIGHT YEARS ON FIELDS A AND B.

| | | |

### Effect of Different Methods and Time of Application of Fertilizer.

The results presented in Table VII were obtained from experiments planned to show the effect on yield of seed cotton—.

*a.* From applying all the fertilizer in the drill before planting;

*b.* From dividing the fertilizer into two equal parts, applying one-half in the drill before planting and the other half as a side dressing about July 1;

*c.* From applying all of the fertilizer broadcast before planting, the quantity of fertilizer and the materials entering into it being the same in all three cases; and

*d.* From making the application of the fertilizer mixture about three times as deep beneath the seed as applied on the other plats and as ordinarily used.

Taking the results as an average of the two fields the increased yields and profits show that it has made very little difference whether all of the fertilizer was applied in the drill before planting, or whether it was divided into two equal parts and one-half put in the drill before planting and the other half applied as a side dressing about July 1, according to season. The average yield and profit from broadcast application of fertilizer was less than that produced by the same quantity of fertilizer when applied in either of the two ways given above.

In both fields the applying of the fertilizer about three inches deeper than is ordinarily practiced gave larger yields than when the fertilizer was applied broadcast, the average annual difference in yield of seed cotton being worth $3.03 per acre. The amount of fertilizer used in the above test was 400 pounds per acre, and it is quite clear that the best and most economical way of using this amount of fertilizer per acre is in the drill before planting the crop. Larger quantities might give as good or better results broadcast, or when applied at different times. Experiments are being made to obtain information on these points.

TABLE VIII—RESULTS OF FERTILIZER EXPERIMENTS WITH COTTON: EFFECT OF DIFFERENT MATERIALS SUPPLYING PHOSPHORIC ACID.

RESULTS IN FIELD B IN 1905, 1907 AND 1909.

| Number of Plat | Fertilizer Application Per Acre | Pounds of Nitrogen (N) Per Acre | Pounds of Phosphoric Acid ($P_2O_5$) Per Acre | Pounds of Potash ($K_2O$) Per Acre | Yield of Seed Cotton in Pounds Per Acre | | | | | | | | Average Yield of Seed Cotton in Pounds Per Acre | Average Increase Per Acre Due to Fertilizer | Value of Increase at 4.5 Cents Per Pound | Cost of Fertilizer Per Acre | Average Value of Increase Over Cost of Fertilizer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | 1908 | 1909 | | | | | |
| 5 | Unfertilized.....O | | | | | | | 447.4 | | 185.0 | | 160.0 | 264.1 | | $ | $ | $ |
| 4 | 77 lbs. 13% blood.....N<br>175 lbs. 16% acid phosphate.....P<br>50 lbs. 20% manure salt.....K | 10 | 28 | 10 | | | | 1312.0 | | 755.0 | | 710.0 | 925.7 | 661.6 | 29.77 | 4.04 | 25.73 |
| 14[2] | Unfertilized.....O | | | | | | | 534.4 | | 180.0 | | 220.0 | 311.5 | | | | |
| †18[2] | 77 lbs. 13% blood.....N<br>155.6 lbs. 18% basic slag.....P<br>50 lbs. 20% manure salt.....K | 10 | 28 | 10 | | | | 1254.0 | | 557.6 | | 625.0 | 812.2 | 408.9 | 18.40 | 4.21 | 14.19 |
| ‡*20[2] | 2000 lbs. stable manure.....N<br>122.2 lbs. 18% basic slag.....P<br>10 lbs. 20% manure salt.....K | 10 | 28 | 10 | | | | 1268.2 | | 575.0 | | 905.0 | 916.1 | 466.9 | 21.01 | 3.20 | 17.81 |
| 23[2] | Unfertilized.....O | | | | | | | 411.2 | | Corn | | 625.0 | (‡)518.1 | | | | |
| 23[2] | Unfertilized.....O | | | | | | | 411.2 | | Corn | | 625.0 | (‡)518.1 | | | | |
| ¶*25[2] | 2000 lbs. stable manure.....N<br>178.6 lbs. 28% phosphate rock.....2P<br>10 lbs. 20% manure salt.....K | 10 | 56 | 10 | | | | 1162.6 | | 650.0 | | 835.0 | 882.5 | 364.4 | 16.40 | 2.99 | 13.41 |
| 4[2] | Unfertilized.....O | | | | | | | 431.8 | | 200.0 | | 165.0 | 265.6 | | | | |
| *9[2] | 2000 lbs. stable manure.....N<br>137.5 lbs. 16% acid phosphate.....P<br>10 lbs. 20% manure salt.....K | 10 | 28 | 10 | | | | 1222.0 | | 770.0 | | 675.0 | 889.0 | 600.5 | 27.02 | 3.06 | 23.96 |
| 11[2] | 500 lbs. unslaked lime every four years.....L | | | | | | | 520.2 | | 215.0 | | 225.0 | 320.1 | 22.4 | 1.01 | 0.63 | 0.38 |

TABLE VIII—Continued.

Results in Field B in 1905, 1907 and 1909—Continued.

| Number of Plat | Fertilizer Application Per Acre | Pounds of Nitrogen (N) Per Acre | Pounds of Phosphoric Acid ($P_2O_5$) Per Acre | Pounds of Potash ($K_2O$) Per Acre | Yield of Seed Cotton in Pounds Per Acre | | | | | | | | Average Yield of Seed Cotton in Pounds Per Acre | Average Increase Per Acre Due to Fertilizer | Value of Increase at 4.5 Cents Per Pound | Cost of Fertilizer Per Acre | Average Value of Increase Over Cost of Fertilizer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | 1908 | 1909 | | | | | |
| 12[2] | 77 lbs. 13% blood.....N<br>175 lbs. 16% acid phosphate.....P<br>50 lbs. 20% manure salt.....K<br>500 lbs. unslaked lime every four years.....L | 10 | 28 | 10 | | | | 1350.8 | | 705.0 | | 870.0 | 975.3 | 673.0 | 30.29 | 4.67 | 25.62 |
| 14[2] | Unfertilized.....O | | | | | | | 534.4 | | 180.0 | | 220.0 | 311.5 | | | | |

*Only eight pounds of potash were added to this plat in 1907.

†In the additions of basic slag to this plat in 1907 and in 1909, there was a combined shortage of four pounds of phosphoric acid per acre for the two years, under what is indicated in the fourth column.

‡In 1905 double normal application of phosphoric acid from basic slag was added. In 1909, ten pounds of nitrogen from blood and ten pounds of potash from manure salt was added in addition to the nitrogen and potash supplied by the 2,000 pounds of stable manure.

¶On this plat, corn has been grown in rotation with cotton since 1905, and dried blood and manure salt supplied the nitrogen and potash for the corn in 1906 and in 1908 and stable manure for the cotton in 1905, 1907 and 1909.

(1)As corn was planted on this plat in 1907 the average yield is from two years results instead of three as with all the other plats mentioned in this table.

### Effects of Different Materials Supplying Phosphoric Acid.

The experiments on Field B, results of which are reported in Table VIII, were designed to determine primarily the relative value of acid phosphate, basic slag and finely ground phosphate rock as carriers of phosphoric acid for cotton grown on clay loam type of soil. It is quite evident, taking all the conditions into consideration, that for the period covered by these experiments acid phosphate was a decidedly more profitable source of phosphoric acid than either basic slag or finely ground phosphate rock. It would be expected, however, that the two latter materials would possibly make a better showing as carriers of phospheric acid in subsequent years than they did during the three years covered by these experiments.

## II. Varieties, Culture and Fertilization of Cotton on Piedmont Cecil Sandy Loam and Red Clay Soils

Eight years' fertilizer and variety experiments have been conducted on the red clay loam soil of the Experiment Station Farm. On basis of these results and other information which we have, the suggestions below are given for the culture and fertilization of cotton on the red clay loams and red clay soils of the Piedmont, and the varieties of cotton which are best suited to them.

Cotton is not a hard or exhaustive crop on the soil, when the soil and crop are handled with care and intelligence. A bale of cotton (1,000 pounds of seed and 500 pounds of lint) removes from the soil in round numbers:

31 pounds Nitrogen,
14 pounds Phosphoric Acid, and
15 pounds Potash,

worth at present prices of fertilizer ingredients $7.89. Only 47 cents worth of this is carried away in the lint. The seed can be sold or exchanged for enough to return in commercial fertilizer considerably more plant food than the lint and seed took from the soil. If the seed be exchanged for cotton-seed meal at the rate of pound for pound, the value of the total plant food secured in the meal will be about double that contained in the seed. The stalks, leaves, and bolls, which should never be burned or otherwise removed, and 90 to 95 per cent of which have come from the air, add vegetable matter or humus to the soil. If the land is liberally fertilized in the right way and protected from surface washing, it should continue to produce large and profitable crops of cotton from year to year, and with a good rotation and proper fertilization will increase in fertility and productiveness. None of our other staple crops are as easy on the soil as cotton when handled in the way indicated above.

*Preparation and Cultivation.*—The land should be thoroughly and well prepared by breaking in the fall or early spring to a depth of 6 or 8 inches, and the soil may be gradually deepened beyond this to advantage. Before planting, cut up well with a disk harrow to get rid of clods and to make a good seedbed and run off rows 3½ to 4 feet apart and on very fertile land 4½ feet. As a rule the fertilizer should be put in the drill before planting and the cotton planted on a level or just above the level, according to the season and drainage condition of the land. Weeders and light harrows may be run across the rows two or three times before and after the cotton is up and before cultivation with cultivators and hoeing begins. When the crop is well up and danger of frost is over, hoe and thin to a stand of 15 to 18 inches in the drill, leaving as nearly as possible one stalk in a place, and giving greater distance in the row and between rows as the productiveness of the land increases. On thin land the rows should be closer together and the cotton closer in rows, as the stalks do not grow very large; but distance should be given both ways as the land increases in productiveness, from whatever cause brought

about. Cultivate with good one or two-horse cultivators, which will not require more than two furrows at greatest to the row, every ten days to two weeks and as nearly as possible after rains to keep down grass and weeds and to conserve the supply of moisture. The cultivation should be comparatively deep early in the season, becoming shallow as the crop grows and root system develops. As the season in the Piedmont is short for cotton it seems desirable not to continue the cultivation late on strong lands, as this will stop growth earlier and hasten maturity.

*Varieties.*—During the past twelve years one hundred and eight different varieties of cotton have been tested at the Experiment Station farm, some of these running through the entire period. Where for any reason difficulty is experienced in getting the cotton to thoroughly mature before frost it will be well generally to use one of the early maturing varieties mentioned below, however, if best of the large bolled varieties will mature safely before being caught by cold weather, they will generally produce the larger returns per acre. They will generally make a larger and more showy growth of plant, produce larger bolls, but the percentage of lint to seed will be smaller by two to five per cent than that on an average produced by the small bolled varieties. The long staple varieties generally produce a comparatively small percentage of lint to seed and are generally later in maturing than most varieties of the other two types. Among the varieties of the different types that have done well in the Experiment Station tests are—

| *Large Bolled.* | *Small or Medium Bolled.* | *Long Staple.* |
|---|---|---|
| Culpepper's Re-improved. | Cook's Improved. | Lewis Long Staple. |
| Mexican Big Boll. | Sugar Loaf. | Columbia Long Staple. |
| Cupepper's Improved. | Broadwell's Double Jointed. | Young's Special Long Staple. |
| Brown's No. 1. | Toole's Prolific. | Hartsville No. 7. |
| William's Improved. | Hawkins' Extra Prolific. | Acme. |
| Triumph. | Dillon Wilt Resistant. | Webber. |
| Cleveland Big Boll. | Moss' Improved. | Haaga. |
| | | Keenan. |

The results of variety tests for 1913 are published with a summary in Station Bulletin No. 226. These results can be had for study by any one specially interested in them.

*Fertilization.*—Analyses of these soils show that they are very low in phosphoric acid, high in potash, and have a fair supply of lime, the quantity of nitrogen depending on the amount of vegetable or organic matter in the soil. Experiments show that phosphoric acid is decidely the most needed constituent for the production of cotton when grown on soils of this type. It is not possible, with present results, to say just what is the best proportion of these three constituents for most profitable returns, but it is certain that the fertilizer should carry a very high percentage of phospheric acid and comparatively low percentages of nitrogen and potash. The indications are that a mixture containing 10 or more per cent phosphoric acid and 2 per cent each of nitrogen and potash will give close to if not the best returns. This mixture should be used for best results at the rate of at least 400 pounds per acre, and as much more as one can afford up to 600 pounds.

The nitrogen may be all derived from blood, tankage, cotton-seed meal, or similar products, or in part from one or all of these, and in part (up to one-half) from nitrate of soda or sulphate of ammonia.

Kainit, manure salt, sulphate or muriate of potash may furnish the potash, and acid phosphate the phosphoric acid. Four hundred pounds of the above mixture would contain 40 pounds phosphoric acid, and 8 pounds each of nitrogen and potash, and 600 pounds would contain 60 pounds phosphoric acid and 12 pounds each of nitrogen and potash. The required amounts of phosphoric acid in 400 and 600 pounds respectively of this mixture would be supplied by 250 and 375 pounds of 16 per cent acid phosphate; the nitrogen by 61.5 and 92.3 pounds of 13 per cent dried blood, and the potash by 40 pounds and 60 pounds of 20 per cent manure salt. Other materials or other grades of these same materials may be used, and it will not be difficult, knowing just what they contain, to use such quantities of them as will be necessary to furnish the required amount of plant food, having in mind that it is the specific number of pounds of phosphoric acid, nitrogen, and potash that is desired, rather than a given weight of mixed fertilizer.

It is not more, but perhaps less difficult to calculate the number of pounds of nitrogen, phosphoric acid, and potash to be applied per acre to any given crop from materials which are to be had than to estimate the exact number of pounds of the materials to make a formula of a certain composition: as for example, in an 8-2-2 goods. The question of filler does not have to be considered in doing this, as is necessary in making a fertilizer formula in the usual way. When it is desired, for instance, to apply the equivalent of 400 pounds per acre of a fertilizer mixture containing 10 per cent of available phosphoric acid, and 2 per cent each of nitrogen and potash, or 40 pounds of phosphoric acid and 8 pounds each of nitrogen and potash, it is only necessary to divide the number of pounds of plant food desired per acre (40, 8 and 8) by the percentage composition of the materials to be used, as follows:

| Number of Pounds of Plant Food per Acre Wanted | | Percentage Composition of the Materials to be Used. | | Number of Pounds of Fertilizer Materials per Acre to Apply |
|---|---|---|---|---|
| Phosphoric Acid 40 Lbs. | ÷ | 16 Per Cent Acid Phosphate | = | 250 Pounds. |
| Nitrogen 8 Lbs. | ÷ | 13 Per Cent Dried Blood | = | 61.5 Pounds. |
| Potash 8 Lbs. | ÷ | 20 Per Cent Manure Salt | = | 40 Pounds. |

The best and most economical way to apply this fertilizer is in the drill before planting, though there is no objection to dividing the application into two parts, putting one-half in the drill before planting and applying the other half as a side-dressing around July 1, according to season and growth of crop. It is certain that quantities of 400 pounds and less of fertilizer should not be broadcast.